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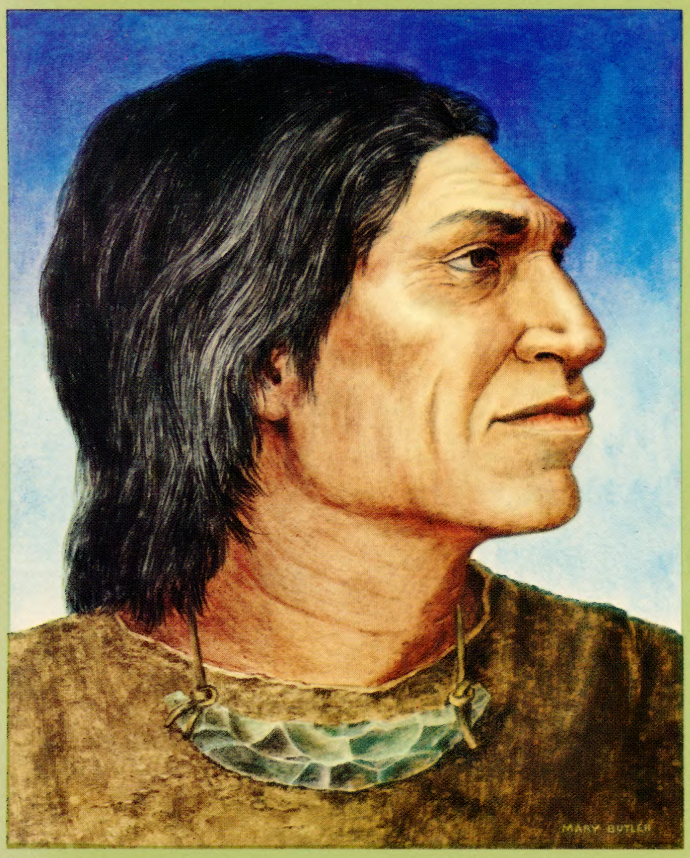

THE ANCIENT CALIFORNIANS

Rancholabrean Hunters of the Mojave Lakes Country

Emma Lou Davis, Editor

NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

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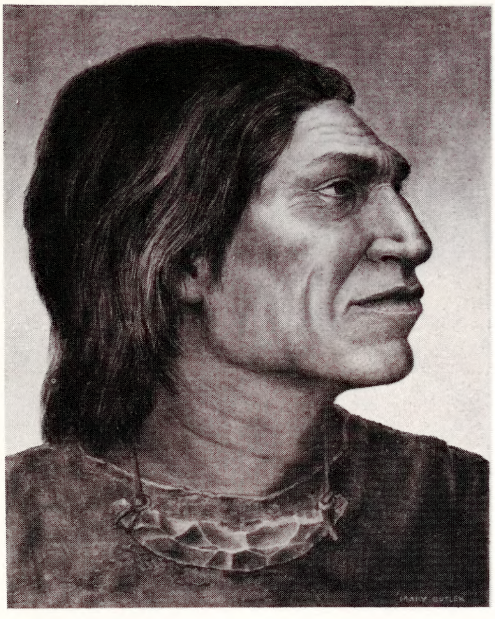
COVER PORTRAIT: Conceptualized Lakes Country Man by Mary Butler, based upon an ancient human skeleton found at Del Mar, California.

THE ANCIENT CALIFORNIANS
RANCHOLABREAN HUNTERS OF THE MOJAVE LAKES COUNTRY



THE ANCIENT CALIFORNIANS
Rancholabrean Hunters of the Mojave Lakes Country

Emma Lous Davis, Editor

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NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

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Del Mar Skull, photo courtesy of the San Diego Museum of Man.

"... it seems hard to deny that the central creative activity in archaeology, like in all scholarship, lies in induction, in outstripping the narrow base of available facts to suggest new and essentially speculative unities."

R. C. Adams

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Foreword

I HAVE HAD the stimulating experience of knowing and following the imaginative field research and publications of Emma Lou Davis as a friend and colleague for some 20 years. She has been a strong proponent of interdisciplinary studies of Early Man Pleistocene research in western North America over this period of time. Her research is aimed at unraveling the mysteries of when people first arrived in North America and the relationships of these people to their environment in the Pleistocene and Holocene.

Dr. Davis is indefatigable, which is not surprising when you consider that she walked across Siberia and China in 1936 and 1937. Further evidence of her tenacity came to light when she had to reconstruct her MA thesis after the original copy and material were burned in a house fire in 1961. She received her PhD from UCLA in 1964, somewhat later in life than most of us, and since that time she has been involved constantly with interdisciplinary field research and reporting.

Highly qualified scientists in the various fields of geochronology, as well as many interested and tireless laymen, without whom her field research would not have been possible, have worked with Emma Lou throughout her career.

This interdisciplinary report, *The Ancient Californians—Rancholabrean Hunters of the Mojave Lakes Country,* presents the preliminary results of field work carried out in the China Lake region of southern California between 1969 and 1974 by Dr. Davis and her scientific colleagues and laymen volunteers.

The evidence presented to support the tentative conclusions of the authors results from a variety of innovative field techniques developed by Dr. Davis and her crews for locating, recording and determining the stratigraphical relationship of artifacts, faunal and environmental evidence.

Among the significant contributions of this volume is the evidence that appears to demonstrate conclusively for the first time the presence of people in North America before 15,000 BP. The authors have established a Proto–Clovis Phase, which developed into Clovis, and suggest that Clovis developed in the West and spread East. The hypothesis that by 15,000 BP considerable cultural diversity had begun in the New World is of major concern to students in the field of Early Man.

The amount of work and effort represented by this report is impressive. Some readers will find some of the ideas put forth provocative and controversial and contrary to traditional thinking on the subject of when people entered North America and what developed thereafter. I find this one of the stimulating aspects of the report. Dr. Davis has never backed away from a controversy, and this report is no exception. She is the first to acknowledge the tentative nature of some of their conclusions. Without this sort of approach little progress can be made. In most cases the authors have distinguished fact from hypothesis and proposition. Readers will find this report interesting and stimulating whether or not they agree with all the conclusions. I hope that others will adopt some of the ideas and field techniques presented.

Richard Shutler, Jr.
University of Iowa
January 1976

Preface

IN LOOKING back over this book, I can now see how experimental it is. The significance of many kinds of information became clearer as different arrangements of them were tried, changed or discarded. Many isolated and widely spaced facts have been stretched to the limit to connect them and thereby bring into focus some measure of reconstruction of ancient and insecure lifeways over a vast passage of time.

The last of the saber tooth cats and the first of the humans drifted in and out of this valley as transients during uneasy times when there were extreme and rapid changes in the lake and general climate. A challenging existence was everybody's lot. Passing millennia saw Lake China transformed from a wind-ruffled inland sea, to expanses of pond and marsh, to desert floor; and sequentially change back.

Doing this work and organizing it together in a coherent record has been a growth experience. Slowly, but clearly, I saw how little I knew as the synthesis progressed.

This is a very female book. Hopefully, it contributes a different voice, different attitudes and values from male traditions of archaeological writing in which, somehow, the actors become lost in the gimmicks and stage props. The carefulness is the same. There may be more devotion to detail (women always have been good at remembering where things should be put on shelves!). But the focus has been on the people, their diversity, their energy and inventiveness. At first unknown, they gradually materialized and became friends —the woman who made those two nearly identical skinning knives; the man who threw away a base of a broken lanceolate knife on Stake 25, and dropped its companion piece in a camp at 25 NW.

This is not a book about full-time Elephant Hunters (a male myth, not substantiated by our information). It is about peoples of the marsh: setting snares for muskrats and nets for ducks; gathering eggs on a spring morning when brant were feeding; when there was enough dried horse meat in camp to tide the family over until the next camel. These were people who spent spring and fall near flyway marshes, summers in higher pastures and forests and autumn collecting winter stores—nuts for caches, berries for pemmican—in a round of life.

E. L. D.
July 1975

Acknowledgments

WE THANK the National Geographic Society for supporting grants numbers 861 (in 1970) and 936 (in 1971-72); the National Science Foundation for grant number 37002, with an additional codicil for ^{14}C dates; the Natural History Museum of Los Angeles County for many kinds of assistance, including storage space; and the Natural History Museum Foundation for sponsoring and administering our grants.

Also, we thank a number of faithful volunteers: Tom and Friedel King who helped with surveying; Ron Henry, Jim Williams and Don Snyder who walked many a long mile dragging rods; Stan Berryman and Ron May who shovelled sand by the ton and wheeled it away in a barrow to help us discover that there *are* buried Paleo-Indian sites in this desert. Clayton Panlaqui set up our system of stakes and acted as chief surveyor, tying in features to conform with the United States Navy coordinates on the ranges.

Warren Hubbard photographed the edge-punched analysis cards, which illustrate Chapter 4. Gena Van Camp followed by Paul Hill relieved me of most of the drafting work. Gordon Dickensheets and Joe Berlant helped with the finish-typing. Robert Boyd contributed far beyond the call of duty with special photographs of artifacts.

Above all, we thank the United States Naval Command, Naval Weapons Center, China Lake, California, for permission to pursue this project, and for loans of equipment. Were it not for Naval protection of the scientific resources on the missile impact ranges, there would be no China Lake Program. The archaeological and paleontological records would have long ago been stolen by pot-hunters, and this report could never have been written.

THE ANCIENT CALIFORNIANS
RANCHOLABREAN HUNTERS OF THE MOJAVE LAKES COUNTRY

THE ANCIENT CALIFORNIANS

Rancholabrean Hunters of the Mojave Lakes Country[1]

By Emma Lou Davis, Editor[2]

ABSTRACT: The China Lake Program is a study of ancient peoples of the California Lakes Country; their life styles and environment. The Lakes Country was a broad corridor between the Sierra Nevada and Rocky Mountains, a territory that at times offered a good habitat for plants, animals and people. At its best, this corridor was a savanna—a grassland with fens and marshes, broad lakes, sluggish streams, gallery forests and patches of xeric woodland, such as juniper. From north to south, it stretched through the Great Basin, the Mojave and Colorado deserts and into Baja California.

The first Americans who wandered into the Lakes Country were descended from many small bands of PaleoSiberians who had trickled across from an Old World to a new one without noticing any difference. They were general foragers with boreal adaptations and stone tools of simple patterns characteristic of eastern Asia. Some of these people drifted into Alaska on foot and some, very likely, used watercraft and followed the coasts. Presumably, tens of thousands of years were required for such folk to infiltrate the Americas a step at a time. As they moved through the Lakes Country, they left a faint and discontinuous trail of their stone tools: originally simple tools, which now are almost obliterated by weathering. Later people of the Lakes developed a beautiful and sophisticated toolkit of special instruments that we call Classic Clovis.

To study these PaleoAmericans, a small team of specialists in half a dozen fields of science has been required: paleontology; geology; paleoecology; field botany; pedology; archaeology; radiometric and racemization dating. This prolonged and intensive work has revised our view of North American prehistory as follows:

1. For the past 40,000 years, the Lakes Country, an intermontane western corridor, was at times a cold steppe and xeric woodland. During such optimal periods, it particularly was a suitable habitat for human foragers, and for a Rancholabrean fauna of large herbivores, which supplied a part, but not the balance of the people's subsistence.

2. During Classic Wisconsin glacial maxima (22,000–12,000 BP), there were no Great Plains as they recently have been known. That country east of the Rockies was occupied by boreal forest, sand dunes, parkland and tundra—a habitat less desirable than the Lakes Country.

3. Therefore, it is suggested that there were intervals when both migration and cultural evolution of PaleoAmericans occurred in the very far West—coastal California and the Lakes Country Corridor. Within the latter, Lake China Basin now provides a laboratory for comparative studies.

4. Population numbers and cultural diversity increased with time, so that by 15,000 years before the present, the Great Basin probably was culturally and linguistically complex and many different groups of people had long since spread through Central and South America.

5. In Lake China Basin, a technology of broad pressure flaking rather suddenly replaced irregular percussion. Thick, ovate bipoints and cordiforms were supplemented by a new tool—long, lanceolate knives with a single, weak shoulder and multiple, basal flutes. These changes appear to have taken place between 14,000 and 12,000 years ago, a Proto-Clovis Phase.

6. After the present microcyles of drying commenced about 11,000 years ago, a number of events rapidly shaped prehistoric events in the Lakes Country. Proto-Clovis lithic and hunting technologies evolved into Classic Clovis marking a climax of population, hunting activity, butchering techniques and lithic virtuosity; at the same time, boreal forests east of the Rockies were being replaced by grasslands.

7. For these ecological reasons, Clovis hunters and the last of the threatened megafauna drifted southeastward around the Continental Divide and then north into the opening ranges.

8. These propositions, if substantiated by continued field work, would account for the sudden appearance of Clovis technologies east of the Divide and the apparent long development of these cultural manifestations in the basin of Pleistocene Lake China.

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INTRODUCTION

By Emma Lou Davis

The Mojave Desert

The Mojave Desert is among all things contradictory—inner visions and drab flats; rock needles and swamp muck; black basalt against a neon sky, above a translucent, perfect flower growing without visible stem on the gravel floor. Storms explode in a riot of wild yells and downpour. Evening is tranquility, a song singing to itself. And there are few other places where you get such tired, frozen feet.

This beautiful place is a country of color and shadow—tiny plants, nocturnal animals, salt flats and gravel windrows inside a rim of volcanic mountains. When day breaks, every mountain stands out clean, every little cloud shines. During the wheeling hours of day, the light changes to a flat blank and sweat runs down from hidden springs in our hair until shadows lengthen, each granule and artifact casting its own, and we reach for jackets. As shadows lengthen, the desert world begins its color transformations: rusts, ochres, purple-brown, black and electric blue. And at night, moonshine turns it to sea.

This is the last of the quiet places, so silent that flight feathers of ravens overhead cut the air like tearing silk.

During five years we worked here very slowly, only on occasional weekends as the Naval testing schedule permitted—a slowness that proved to be a great asset. It forced us to rethink our work, improve our techniques, and soak ourselves with the environments and materials of a long study in prehistory. We set ourselves well-measured deadlines and met them: this interim report is one of those nodal points, a good stopping place at which to pause and review what has been done—to pull it all together—before proceeding into the next stages of the work. For me, this was a continuous period of growth and insight, a period when strong bonds formed with my co-workers. I also learned to love the desert. And finally, during four months of daily work with the artifacts, a strange bridge gradually formed between myself and the stone, like an intense involvement. It was a two-way communication in which I talked and sang to them like an Eskimo sculptor with a fresh block of ivory—singing "who are you who lives in there?"—and they replied in kind. It was during this period that the knowledge and perceptiveness of my friends, particularly Gena Van Camp, guided some of the way across underwater stepping stones to the past. The stepping stones were the tools.

Chapter 1
GENERAL BACKGROUND

By Emma Lou Davis and Carol Panlaqui[3]

Scope of the Report

This report is a preliminary one, a first scan of what has been accomplished so far during the first five years of the China Lake Program (Fig. 1). The report reviews this work, resorting and arraying masses of raw data, which comprise the following:

1) More than 5,347 artifacts;
2) more than 15,700 flakes;
3) plane table mapping of more than 3km^2 of Paleo-Indian site surfaces;
4) initial studies of the late Pleistocene geology of Lake China;
5) identification and cataloging of more than 900 bone fragments of a Rancholabrean fauna;
6) correlations of certain faunal elements with Paleo-Indian hunting and butchering activities;
7) initiation of palynological and paleoecological studies;
8) preliminary classification of all artifacts by the following three criteria: function; degree of weathering; morphology. This sorting has produced some new and unexpected tools, such as Time-marker Groups (The Core Tool Tradition); Phase Groups (like Classic Clovis vs. Proto-Clovis); and such use categories as crescentics and crescents, cutters and "steak knives";
9) recording on edge-punched cards of 412 key artifacts used in defining the various classes (see Chapter 4);
10) backhoe trenches and test excavations to discover stratigraphies and correlations with artifacts.

The work of arraying and synthesizing also has generated an extensive structure of hypotheses for interpretations of both parts and the whole of a vast, disparate corpus of information:

1) a time scale for culture-historical changes;
2) tentative seriation of the stone tools into long (but interrelated) technological sequences with a possible time-depth of 45,000 years (Table 1);
3) recognition of the value for PaleoIndian studies of these broad and open categories, as opposed to rigid sterility of a narrow typological approach.

Eventually, the organized body of data and web of testable hypotheses will prove ideal for sophisticated, multivariate analysis. However, in this first presentation, only the simplest scaling will be attempted. First, we must become very clear about what questions need to be asked, and how best to answer them, using every means at our disposal. If digital mathematics does it—we will use statistics; if analog simulations are most heuristic, they will be used; and we know that intuition is an ultimate form of wisdom. This preliminary array of digested information is a firm base for many future, investigative enterprises.

FIGURE 1. Map of California showing the location of the Lake China study.

[3]Maturango Museum, Ridgecrest, California 93555.

TABLE 1

A proposed sequence of Lake China Basin artifact technologies, expressing cultural changes from about 4,000 to 45,000 years BP. Criterion: weathering.

Older Traditions	Cultural Blends	Newer Intrusions
Early Core Tool Tradit. 45,000–27,000 years BP		Cordiform knife/points
Late Core Tool Tradit. 27,000–25,000 years BP		Introduction of ovate knife/points.
Late Wisconsin Cult. I 25,000–20,000 years BP		New tools and improved techniques. Crescents.
Late Wisconsin Cult. II 20,000–15,000 years BP		Long Ovate points diverge a) toward Lake Mohave type, b) toward San Dieguito type
Early L. Mojave Early San Dieguito	Proto-Clovis Cult. 15,000–13,000 years BP	Refined percussion. Wide, thin lanceolate knife/points. Shouldered knife/points.
	Classic Clovis, Sandia 13,000–10,000 years BP	Introduction of heat treatment of silicate rock
Migrations eastward into new grasslands of the trans-Rockies areas		
	"Pinto" Phase Cultures (Milling Archaic) 6,000–3,000 years BP	Introduction of parallel, pressure flaking.
	Fully evolved Desert Cultures 4,000 BC-AD 1850 Milling Archaic, 4,000 BC-AD 1,500 Pottery Archaic, AD 1,500–1850	

BEGINNING AND DEVELOPMENT OF THE LAKE CHINA PROJECT

Early in September 1969, two college students named Dick and Bill Fagnant came down from the China Lake Naval Weapons Center with a large grocery box full of artifacts, which they wanted appraised. The contents were startling: fluted knife/points; end scrapers; beaks; choppers that almost were obliterated by weathering; and long ovate knife/points as deeply eroded as the choppers. There was no doubt that the Fagnants had found their way onto PaleoIndian sites of major importance. I immediately made arrangements with the China Lake Command to visit the area, which was well protected because it happened to be in the middle of the bombing ranges (Fig. 2).

Two weeks later on a blistering afternoon, a small group of us climbed out of our vehicles on G-1 Road, a lateral across the Naval Weapons Center testing areas in the basin of Pleistocene Lake China. We were an assorted crew of civilian professionals from the Base, college students, members of the Mojave-Sierra Archaeological Society and my assistant and I from the San Diego Museum of Man. We fanned out and started crunching over gravelly slopes led by the young Fagnants, who knew the district well and had marked various site localities on a topographic quadrangle sheet. The "sites" didn't look like much—a lot of gravel, some sand, a few playas, an occasional pile of tufa and a weatherbeaten flake or artifact at rare intervals with only an occasional concentration. However, judging by the Fagnant collection, this impoverished-looking landscape contained "sign" of a poorly defined culture called Lake Mojave, and an equally elusive one called Clovis (known on the High Plains from an association of large, fluted implements and dead mammoths). In California, no one, particularly ourselves, had any clear idea of the characteristics, dates or interrelationships of these cultural will-o-the-wisps. On the basis of five years of painstaking work since that time, however, we are now able to point out certain kinds of reasonable relationships and sequences, and have outlined a model (seriated on the basis of weathering of the artifacts coupled with their morphology and technology) of the suggested

FIGURE 2. Position and topographic setting of the China Lake Naval Weapons Center, shown on this map as the Naval Ordnance Test Station. This valley, called "Indian Wells," is the dry basin of Pleistocene Lake China.

cultural history of this region over the past 45,000 years, which may prove useful while it lasts. A preliminary version of this model is shown in Table 1.

In the beginning, it would be difficult to imagine a major search in prehistory starting with a scantier foundation in theory, despite the extensive structure of ideas that has since grown out of our work like a seedling. As time passed and we became more discerning, we were able to make advances in both procedures and interpretations.

1) A sampling program was devised, which was adequate for a huge area.
2) A system of survey squares, each 305 meters on a side was established, together with simple but efficient methods of mapping, artifact harvesting and recording. These procedures are described in Chapter 3 (see also Davis 1975).
3) We developed initial hypotheses, tested and scored them and changed them as needed.
4) By departing from opinions in the literature, we discovered new, functional classes of tools—little scalpels, women's work implements and butchering equipment.
5) Also, new theories about the origins and culture/historical position of the assemblage called Lake Mojave and its relation to Clovis were postulated.
6) In the final stages of artifact analysis and review, the tools began to array themselves into novel sequences, suggesting new progressions of cultural developments in our sampling area as well as time depths of human activities in the Great Basin Lakes Country (Russell 1889), which might be far greater than expected.

But in 1969 we had little concept of how widely PaleoIndian tools were scattered in the basin of Lake China. There was as yet no way of knowing what we were seeking—anything and everything, really. We walked for miles, looking and taking notes. There was so much, yet so little knowledge about it.

The literature of the time offered a few scattered bits of information about western PaleoIndians in work pioneered by the Campbells (1935, 1936, 1937, 1940) and by Malcolm Rogers (1939). This research was revolutionary for its period.

Near the southern California coast, early cultural material had been excavated on the San Dieguito River by Warren and True (1961) and dated somewhat later at 9,030 ± 350 radiocarbon years and 7,080 ± 350 BC (A722A) (Haynes 1967:9). Further east, ancient camps and kill sites were discovered one by one from the Rockies to the Atlantic (Byers 1954, 1966) and summarized by Haynes (1964, 1970). Recently, several excellent, doctoral-level studies of eastern Clovis Phase sites have been written by Hemmings (1970) and Judge (1973); however, in the Mojave Desert little was known (Davis and Shutler 1969). In the basin of Pleistocene

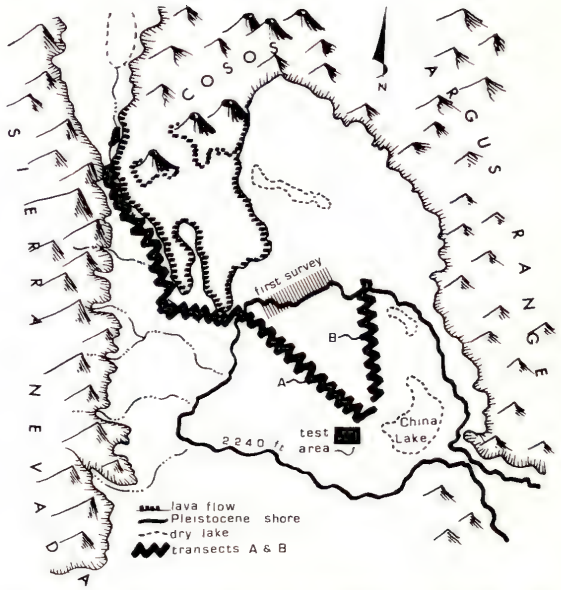


FIGURE 3. Sketch map showing the locations of different kinds of sampling: intensive surveys, first survey, and long transects A and B.

Lake China we had strayed into unknown territory and unknown problems.

Late in the autumn of our first season (1969), we had learned enough to enable us to establish immediate directions for our explorations (Fig. 3). With assistance from the Mojave-Sierra Archaeological Society and some loans of equipment from the Navy, we commenced a foot survey of the 2240 foot contour line of Pleistocene Lake China, presumed to be the last high-water level. The location of this initial survey is shown in Fig. 3, whereas the 2,240 foot shoreline can be seen in Fig. 4. A number of artifacts and a few concentrations of obsidian flakes were found above the shoreline traces. Eleven 25 × 25 foot squares were staked out in these concentration areas, each square being tested by excavation of a random sample of 5 × 5 foot pits. The flakes had no depth and results were negative. It would be another four years before we had completed enough of our mapping program to enable us to predict the conditions under which buried sites would most likely be found.

After finishing half of the originally planned lakeshore survey, we returned to spending our occasional weekends in pursuing other lines of investigation and just before Christmas, we got a startling surprise. Four of us began finding not only scattered artifacts but also mineralized fragments of animal bones, in close proximity to each other, while walking southwest from tracking tower no. 6 into a terrain of low ridges and playas. Late on a Saturday afternoon, Dick Fagnant came upon a cluster of unusually large bones, doubtless a proboscidean. This specimen site was listed as

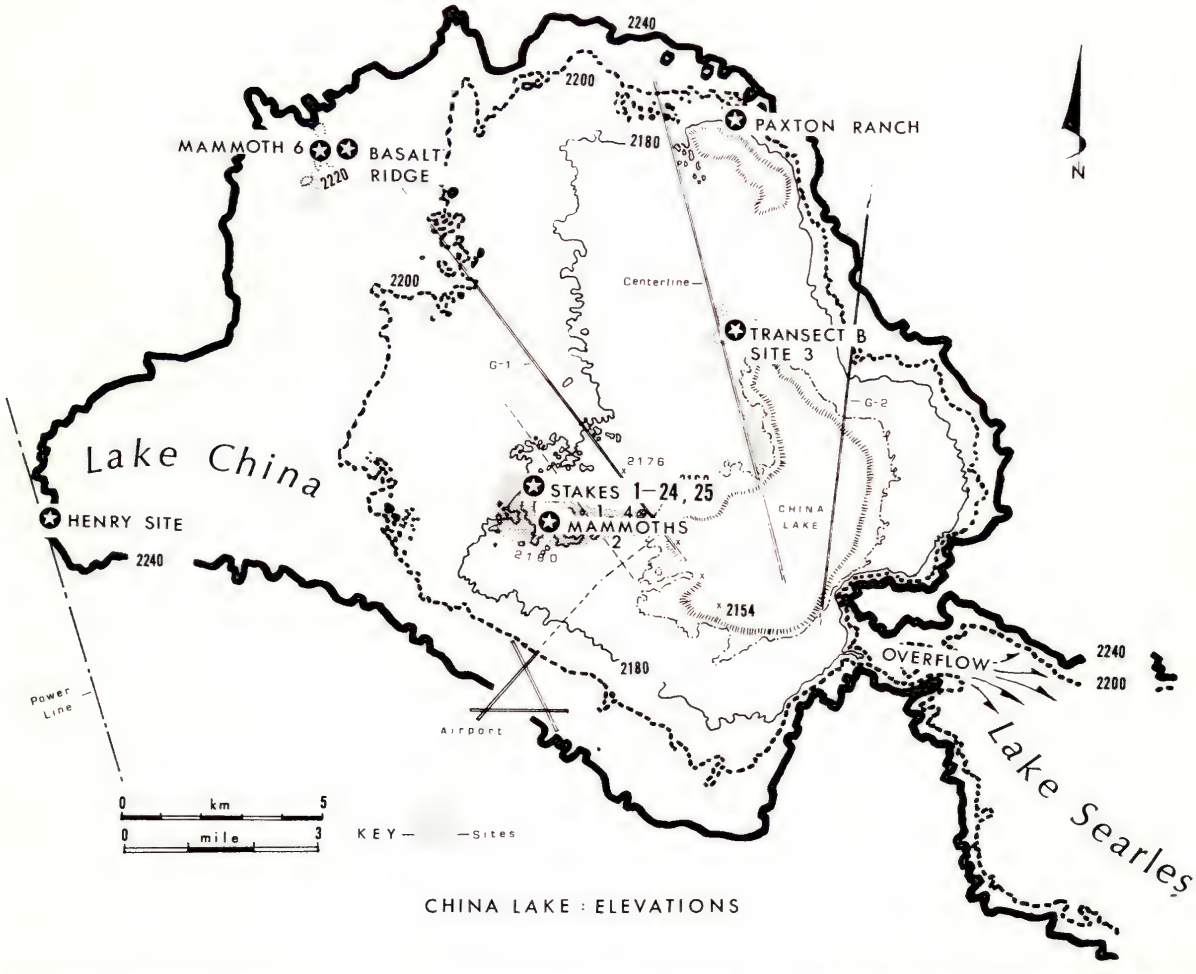


FIGURE 4. Elevations of contour lines, approximately corresponding to fluctuating levels of Lake China which determined the habitats of animals, plants and people.

Mammoth no. 1, and the locus also was an archaeological site, judging from a chopper lying among the remains (Fig. 5). By sunset the following day, the site had been plotted approximately on a quadrangle sheet and given a metes and bound designation of T 25S; R 40E: 28 (the Section number) -A-1. The bone fragments and stone tool were sketched, photographed, collected and boxed for identification at the Natural History Museum of Los Angeles County (LACM).

At LACM, a group of paleontologists identified the bone as proboscidean, either mammoth or mastodon (later narrowed to mammoth) and David Fortsch (who at that time was with LACM) was assigned to visit the Naval Weapons Center ranges with us to appraise the value of this area for paleontological studies. Within the next 30 months, his share of work on the China Lake Project had earned him a Masters of Science degree at the University of Southern California (Fortsch 1972).

At this point, we had in our hands a discovery of unknown dimensions. How much early material lay on

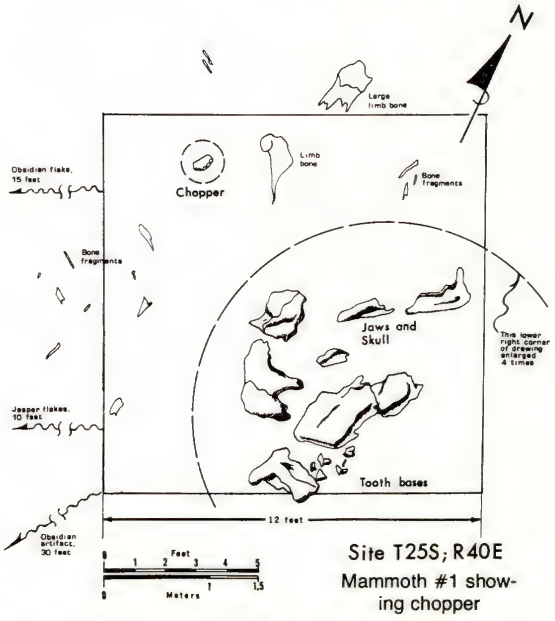


FIGURE 5. Sketch of Mammoth #1 with a chert chopper.

erosional surfaces of Indian Wells Valley, and how widely was it distributed? We didn't know at that time. And how were we going to cope with archaeology which was dotted over many square miles rather than being neatly confined to a single cave or hillock. The first task was to get some idea of the breadth of distribution and to define a workable universe. This required months of legwork on the part of many volunteers, and the help of an expert surveyor, Clayton Panlaqui, who worked with his wife, Carol, to lay out a system of instrument stations, each commanding a view of 305 meters square. This core locality is illustrated in Fig. 6. The entire plan of intensive survey squares and long transects is described in Chapter 3.

The second most important factor in the project also took shape after our first season: a team of workers came together, based on individual ability and interest. Dave Fortsch was our paleontologist. Carol Panlaqui (originally a chemist) took over cataloging, most of the instrument work, completion of the field maps and all local arrangements with the Navy—which sometimes involved intricate diplomacy. George I. Smith (United States Geological Survey) has been the geological consultant because of his extensive knowledge of the geochronology of Lake Searles, the Pleistocene companion of Lake China (Smith 1968, 1977). Davis was the planner and coordinator, legs squad, field photographer, pinch-hit mapper and (at first) the draftsman.

In 1974, all the drawings (except the edge-punched cards, which make up the artifact illustrations) were taken over by Gena Van Camp, another anthropologist. And there were the volunteers—Ron Henry, Ethel Burge, Don Snyder, Tim Kearns, Stan Berryman and Ron May—who got up in the cold black of winter mornings to trudge endlessly back and forth dragging a stadia rod or wearing out their vocal cords shouting

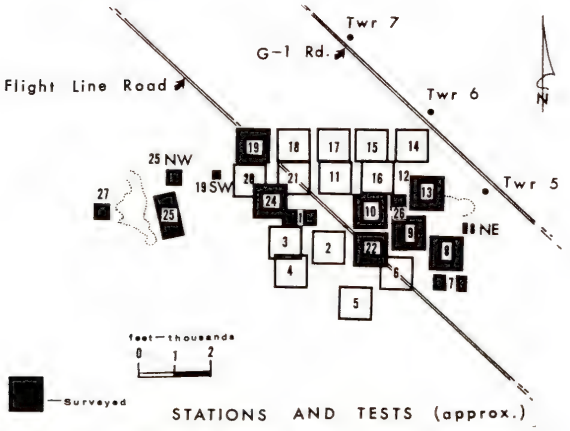


FIGURE 6. Schematic drawing of the intensive survey area. Completed squares are shown in black. All "stakes" measure 305 m (1000 feet) on a side except for #1 and 4 control stakes—#s 19SW; 25; 25NW; 26 and 27. All stakes are discussed and illustrated in Chapter 5.

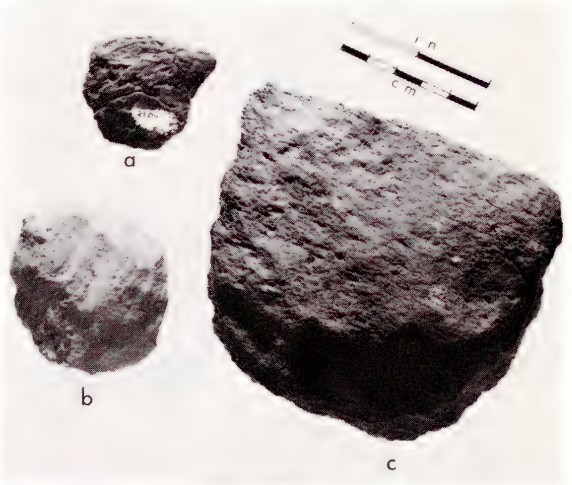


FIGURE 7. Early Core Tool Tradition artifacts from China Lake and Panamint valleys. a) Triangular broad beak, basalt. Stake 25 Dy-1. c) Chopper, basalt, Stake 25 Dy-0. b) Biscuit scraper, c) Chopper, basalt Stake 25 Dy-O.

above the wind, "Artifact!" or "Bone!" Tom King (an engineer with Douglas Aircraft Company) and his wife Friedel plotted profiles and elevations for us. Warren Hubbard, another chemist and professional photographer, solved our problem of converting edge-punched cards into black-and-white illustrations of the artifacts (see Chapter 4). He used high-contrast copying film and darkroom techniques to equalize the somewhat uneven values of the cards and sketches (Fig. 7).

Field work for these preliminary studies began drawing to a close in June of 1974 when Peter Mehringer of Washington State University came down with two student assistants and joined us at Little Lake—a small body of semi-permanent water 25 km northwest of China Lake valley—where we spent a week coring for pollen, sedimentation records and information about the water budget of this segment of the Pleistocene Lake China intake. Results of this work (the first of its kind at Little Lake) are discussed in Chapter 6 by Mehringer.

The final step in preliminary work in the basin of Pleistocene Lake China was an inspection and appraisal of all artifacts and of all "flakes" (most of which are tools) from each quadrant or segment of each site with the exception of Transect B, Site 3 (see Chapter 5). Only about 60% of the Site 3 flake collection was reviewed (we collected over 15 kilos of them). The procedures and scaling systems used in all analyses are described more fully and resultant insights and conclusions are discussed in Chapters 4 and 5. The conclusions came together slowly and did not set into shape until more than three-fourths of the analyses and recording were done. When ideas about the human meanings of all these battered fragments of stone had arranged themselves, the configurations were a surprise. (See Fig. 9A.)

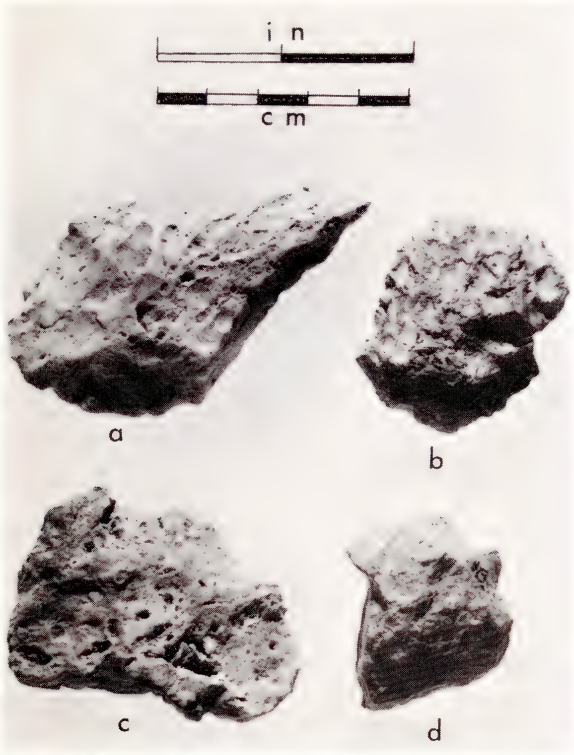


FIGURE 8. Artifacts of a postulated Core Tool Tradition from the basin of Pleistocene Lake China. a) Fragment of chopping tool with spokeshave at top, chalcedony. Stake 22 B-11. b) Biscuit scraper with spur beak, jasper. Stake 25 K. c) Chopper fragment, chalcedony. Stake 25 ? d) Spur beak, jasper. Stake 1 B-52.

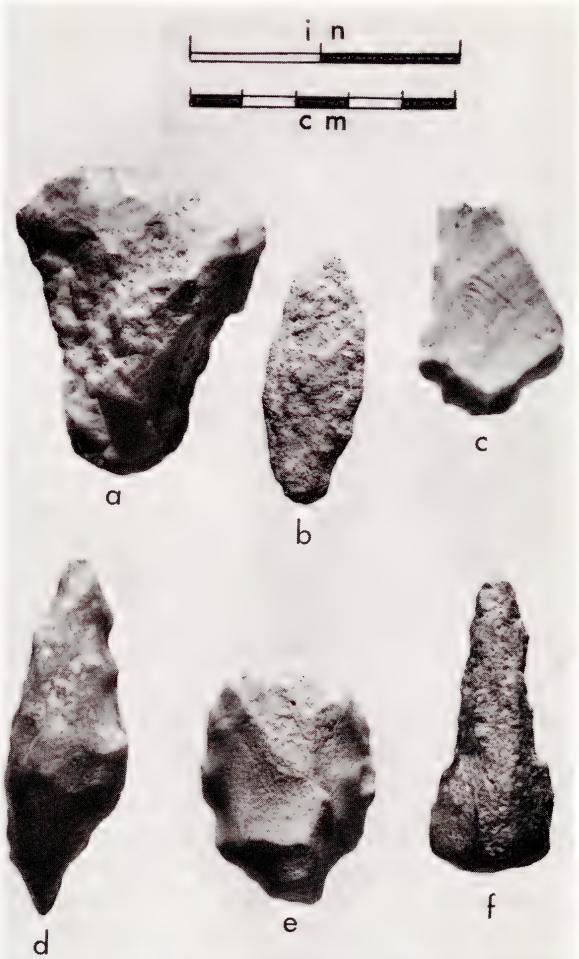


FIGURE 9A. Late Wisconsin Cultures I, basin of Pleistocene Lake China. a) Large end-scraper with spur beak left side, chalcedony. T 25 S, R 40E, 28A-215. b) Long ovate knife/point, rhyolite. T 25 S, R 40 E, 28A-24. c) Four sided scraper, chalcedony. Transect B, Site 3W-29. d) "Slug" scraper, chalcedony. T 25 S, R 40E, 28A-819. e) Biscuit scraper, chalcedony. Stake 9-2. f) Broad beak, long borer, chalcedony. T 25 S, R 40 E, 28A-309.

Since I am entirely responsible for them, as well as for the tenuous constructs on which they are based, this seems an appropriate place at which to summarize a view of cultural history in the northern Mojave Desert as I conjecture it after studying a number of relevant factors such as: differential weathering of China Lake tools; changes in vegetation and climate; fluctuations in lake levels; repeated mantling and denudation of the sites by rises and recessions of the lake; carbonate contamination of radiocarbon dates; and customs of other foraging people. Of all the information bits available to us, the best is the raw data contained in the stone artifacts. These tools fall into distinctive classes, which differ in design, function, relative frequency, preferred materials, technology and degree of physical weathering. When our large sample (5,347 artifacts and 15,754 flakes) is considered, the above parameters have predictable relationships. A sequence of Lake China technologies with proposed spans of time is shown in Table 1.

A MODEL FOR NEW WORLD POPULATION DRIFTS

The array of artifacts from Pleistocene Lake China suggests a long sequence of cultural events and developments as well as occasional introductions of foreign elements, like those associated with the appearance of a Proto-Clovis technology and its (local?) evolution into a classic expression late in the Clovis Phase. This model accommodates our own data and offers explanatory hypotheses, which might answer a number of questions left unsolved in previous models constructed by Mason (1962) or by Haynes (1964) and Martin (1973).

These older models begin (at a midpoint in our sequence) with Clovis in the center stage; therefore, they contrast sharply with the view we have formed of long Great Basin cultural sequences and relatively long periods of time to account for technological variety and change. To be brief, the earlier constructions suggested a Clovis Conquest of the New World—a rush invasion about 11,500 years BP by an unknown people of unknown origin who crashed through an opening

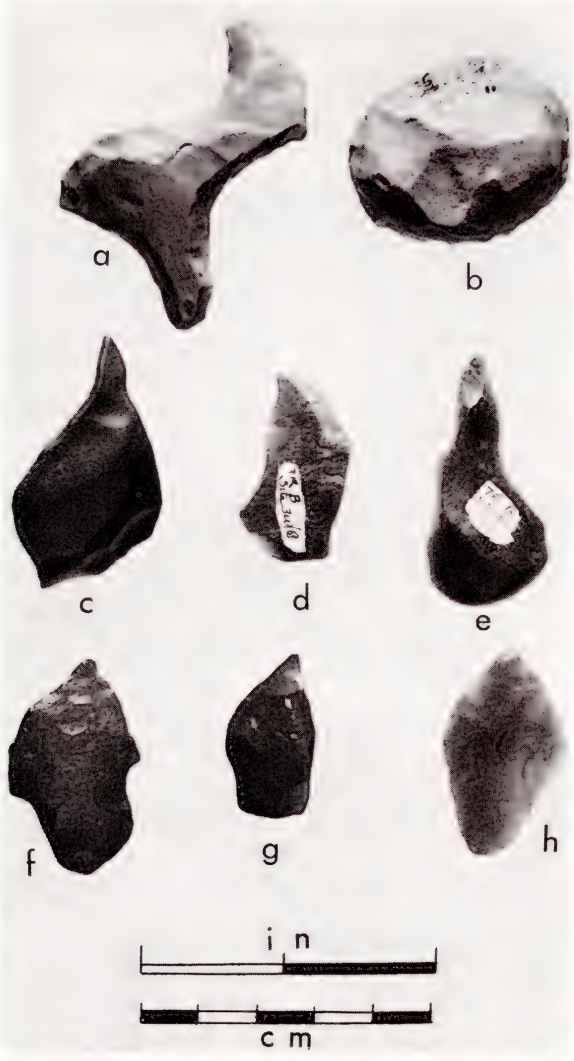


FIGURE 9B. Late Wisconsin Cultures II, Basin of Pleistocene Lake China. a) Multiple radius spokeshave, gray chert. Transect B, Site 3W-34. b) Biscuit scraper, chalcedony. T 25 S, R 40 E, sec. 28A-314. c) Broad beak, long borer, with spur beak at bottom, obsidian. Transect B, Site 3W-16. d) Broad beak, curved obsidian. Transect B, Site 3W-8. e) Broad beak, long borer, obsidian. Transect B, Site 3W-13. f) Bifacial cutter, curved, shouldered-2, with spur beak, obsidian. Transect B, Site 3W. g) Flake cutter, shouldered-1, with spur beak. Transect B, Site 3W-15. h) Bifacial cutter, shouldered-1, obsidian. Transect B, Site 3W.

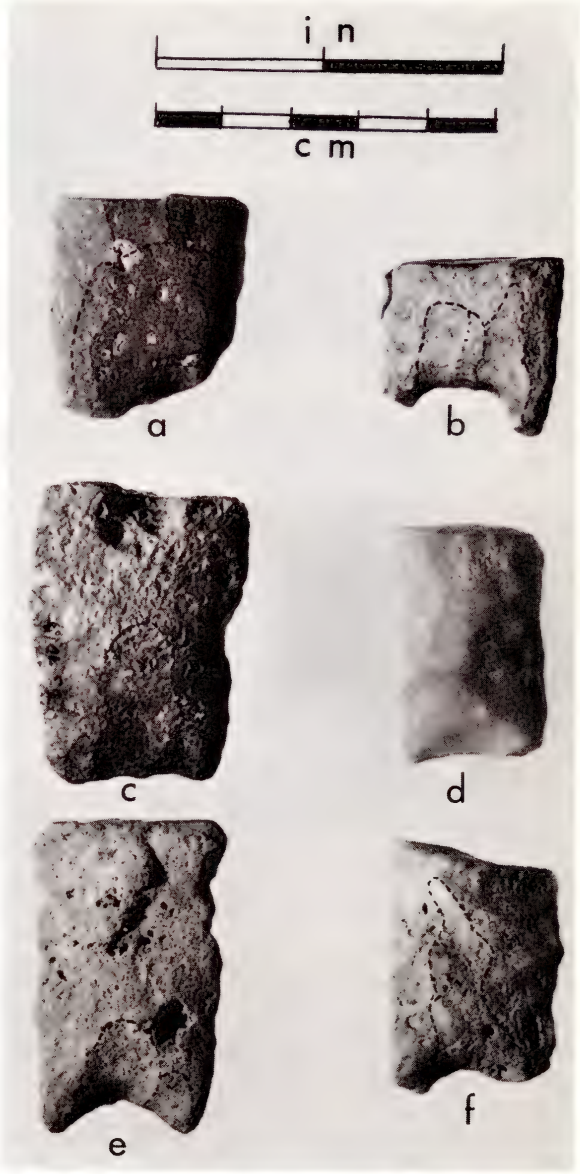


FIGURE 10. Proto-Clovis Phase: new technologies and inventions appear in the basin. a) Proto-Clovis base with shallow flutes, (2), chalcedony. Stake 1 B-9. b) Knife/point base with 2 flutes, gray chert. Stake 1 A-0. c) Large jasper knife with (3) flutes and 1 shoulder. Note characteristic recess beneath shoulder (right). Stake 9 D-13. d) Base of knife/point, 1 shoulder right side, with characteristic recess beneath shoulder. Incipient flutes and basal thinning, chalcedony. Stake 13C-52. e) Knife/point base weathered, with shoulder and sub-shoulder recess (right), jasper. Stake 25 K-1. f) Base of knife/point with 1 faint shoulder (left), pink chalcedony. Stake 19SW 2-1. This looks like work of the same man who made specimen e).

corridor between the Laurentide and Cordilleran glaciers of Canada to storm an entire hemisphere within 1,000 years. The First Conquistadores are thought to have been specialized mammoth hunters who wiped out elephants, camels, horses and mastodons (but why not also moose, elk, deer, bison and antelope?), signing a death warrant for the Rancholabrean megafauna. An alternative to this extinction-by-predation model is offered by Guilday (1967:128–133) who proposes that drastic elimination of a number of large mammals was due to interspecific competition brought about by the climate-engendered extinction of "subhabitats or ecological niches."

Recent work in both the Soviet Union and the Americas suggests that Pleistocene people and animals had a long history together in the New World. Human beings were reaching Alaska and North America before 50,000 years ago (Bryan 1973; Irving 1973; Bada 1974a, 1974b,

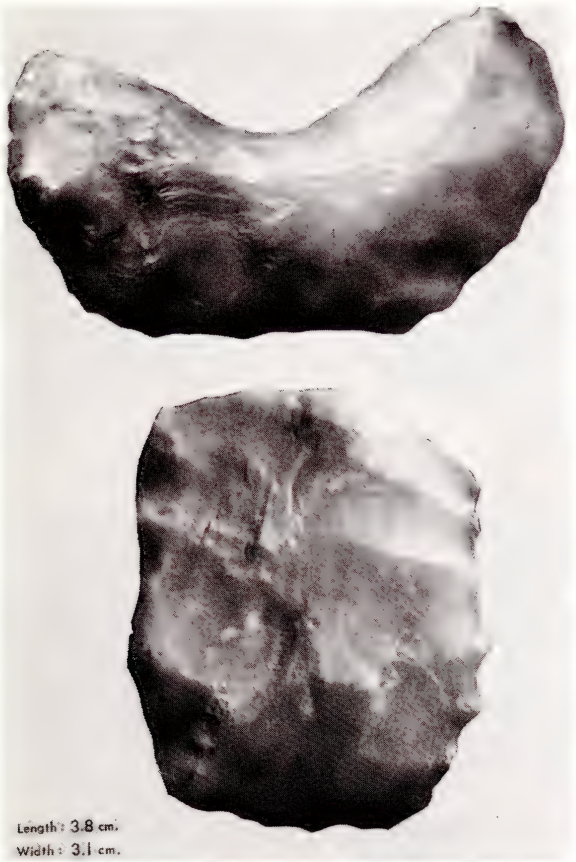


FIGURE 11A. Classic Clovis technical refinements: heat treatment of high quality stone and regularized flaking.

FIGURE 11B. Classic Clovis Phase, basin of Pleistocene Lake China. Examples of refined percussion and pressure flaking applied to high grade, heat-treated chalcedony (Crabtree and Butler 1964). a) Biscuit scraper, chalcedony. T 25 S; R 40 E; -3. b) End- and side-scraper, heat treated chalcedony. M-184-A4. c) Composite tool—concave spokeshave; convex, denticulated shredder and a broad beak, triangular. Heat treated chalcedony. PR2-2.

1975; Rogers 1974; Derevyanko 1975; Lorenzo 1975; Mochanov 1975; Powers 1975). From there, the trail southward might have been a broad corridor between the Cordilleran and Laurentide glacial fields, which were separated widely about 40,000 to 35,000 years BP (Müller-Beck 1966, Figs. 15 and 18). The Northwest Coast was another available avenue for PaleoSiberians with maritime adaptations (Fladmark 1975).

These peoples were small, mobile bands of general foragers who ate everything they could collect or catch, and who were adapted to a boreal habitat in clothing, equipment and social organization. The earliest Americans probably were generalized physically, technologically and socially. They possibly reached the New World in a number of small increments, laying a groundwork for the diversity of North and South American languages. The toolkits they brought with them were at first patterned after simple, chopper/chopping-tool traditions of eastern Siberia and Asia (Powers 1973: 16–23). By 30,000 years ago, some of these groups were well adapted to life in the southern Great Basin just prior to the last Wisconsin glacial maximum, whereas others were working their way through Mexico and into South America.

They did not settle the eastern United States nor those areas that, much later, became the Great Plains prairie country. The reason for this avoidance was an ecological one: there were no Great Plains as we know them. Instead, there were dark forests of conifers (Wendorf 1975:viii), with vast areas of sand on the western part and some aspen parkland and tundra in the north (Wright 1970; Wells 1970).

In contrast, the Lakes Country of the Great Basin—the intermontane region containing Bonneville, Lahonton and Lake China systems of basins—had extensive areas

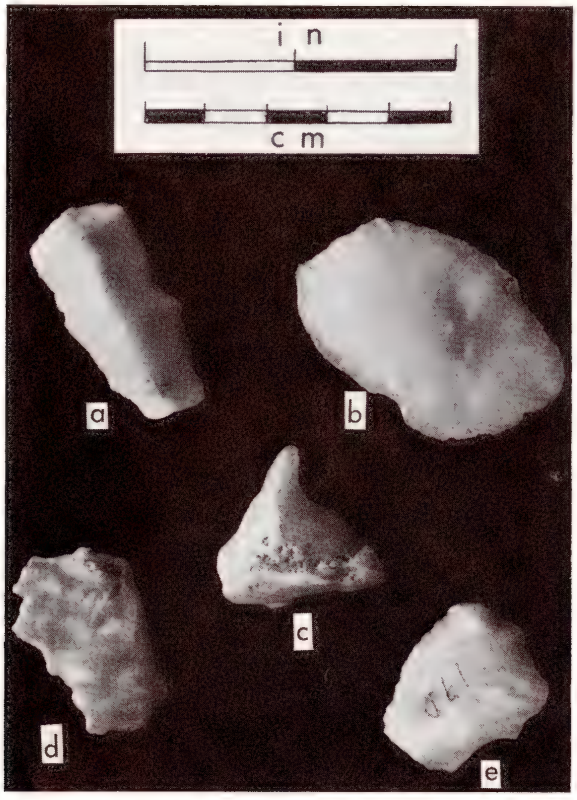


FIGURE 12. Clovis Phase, basin of Pleistocene Lake China: further examples of classical Clovis tools. a) End scraper on a blade. Heat-treated chalcedony CRBR, Site 1, A-5. b) "Steak knife"—finely serrated, woman's meat slicing tool with micro-spokeshave. Heat-treated chalcedony. 19-D. c) Broad beak, curved. Heat-treated chalcedony. Stake 10 A-33. d) Flake saw or shredder, heat-treated chalcedony. Number obliterated. e) Serrated "steak knife" with spur beak (lower right), heat-treated chalcedony. 19 D ?

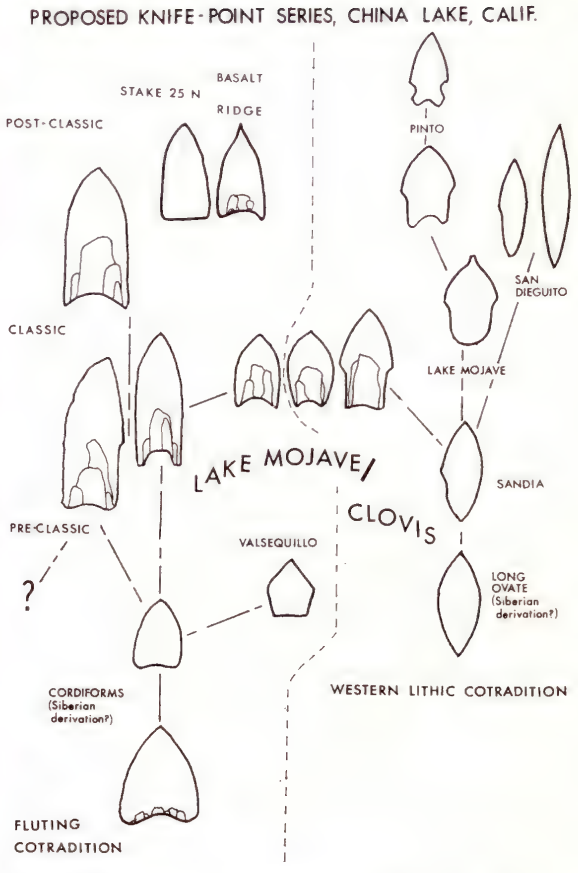


FIGURE 13. Proposed knife/point series: Lake China basin.

of savanna. The Rancholabrean herbivorous fauna from Lake China sites required grasslands for its support. During the Wisconsin glaciations in North America, the Lakes Country was an advantageous place for grazing animals and human foragers. It, therefore, also was an adequate environment for cultural developments (although, being a cold steppe, it was climatically a severe one). Regional progressions of culture and technology are reflected in diagnostic knife/points, which are illustrated in Fig. 13. If this sequence can be supported by comparable discoveries in other Great Basin regions, then the unconformable phenomena of Clovis can fall comfortably into place in a long chain of New World historical events, *because Clovis evolved in the Lakes Country.*

LATE WISCONSIN MIGRATIONS: AN ALTERNATIVE HYPOTHESIS

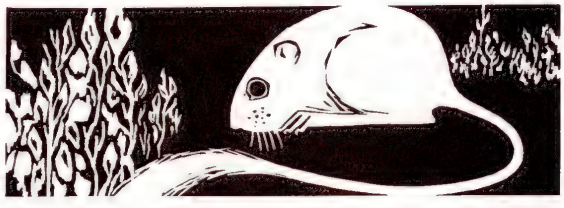
Viewed in this perspective, it appears likely that a cultural peak was reached during the Classic Clovis Phase in Lake China areas prior to 11,500 years BP. *After this, rapid changes took place: the climate became warmer and drier, destroying lake and savanna habitats of the megaherbivores (Guilday 1967) and intermontane regions became less attractive while a spread of grassland made the developing Great Plains more inviting. Both animals and people flowed northeastward, thereby accounting for the mysterious suddenness of Clovis appearances, contemporaneously, over wide areas of the mid-continent.* Climatic shifts also may account for the brief survival of a few mammoths east of the Rockies. The first discoveries of Clovis knife/points (possibly butchering tools) with dead mammoths in these parts of North America may reflect the plight of certain herbivores on a marginal range quite as much as they suggest both skill and specialization on the part of the foraging bands of humans.

Little is known of the subsequent "Pinto" Phase in the Lake China basin. The term Pinto is defined chiefly by descriptions of the Pinto Basin Site (Campbell 1935) and the Stahl Site at Little Lake (Harrington 1957). After this phase, of which the temporal boundaries remain to be drawn, the desiccating valley of Lake China was used only by occasional travellers, most Indians having withdrawn to higher country, which was better supplied with both rain and groundwater.

Chapter 2
PRESENT AND PAST ENVIRONMENTS OF THE VALLEY

By Emma Lou Davis and Carol Panlaqui

The Mojave Desert



The Mojave Desert is deceptive—it appears empty but is secretly rich in life and action; however, these must be approached by a seeker who is willing to wait. Much of the time, plants are dormant; the nocturnal animals are underground; the birds have migrated. Margins of ancient swamps or lakes (where camels were butchered) have been etched away by winds and rills; the fossil soil on which people camped long ago now is invisible. It has been buried or destroyed. Once in a while, however, we can catch the desert in its full strength—a view of its present; glimpses of its many pasts.

On an April morning we walked up the lower gorge of the Pleistocene Owens River, a solitary place of shrubs, gravel and dry rivulets between walls of black basalt. That spring was wet after a winter of rains, and the gorge was a bed of wildflowers waving their colors against coallike rock, or climbing the slopes out of sight. We came to Lower Fossil Falls, where the pluvial river had at times roared over a drop in the volcanic flows, plunging 20 feet to a lower level. Here it slowed and spread through a delta into the open basin of Lake China. Now the dry falls are flanked on each side by walls of recent Indian petroglyphs—abstracts; a personage represented as dead and, therefore, head down; the ubiquitous sheep that may be a glyph communicating the idea of "motion" (Martineau 1973). The basalt, dividing this gallery, is polished shiny, slicked by the sand and torrents of each glacial melt in the past.

And again, in April of 1973, flowers climbed to the foot of the rock, shining against it as though illuminated from within.

THE SITUATION OF THE LAKE

To understand the materials and interpretations of this report, it is essential to conceptualize the place of Pleistocene Lake China—the mother lake in this study. It is called "Lake China" to distinguish it from contemporary "China Lake," and other Wisconsin lakes are referenced in a similar way. Like other Great Basin lakes, its water supply changed with changes in climate and these fluctuations controlled the species and conditions of the biota—plants, animals and a gradually increasing population of humans who were the major consumers in this Web of Life (Storer 1953). The Pleistocene Great Basin, with its systems of ephemeral lakes—Bonneville, Lahontan, Mono, Owens and China—is called "The Lakes Country" in this monograph. These lakes are illustrated in Fig. 14.

Pleistocene Lake China was a broad, shallow, continually fluctuating body of water occupying a basin, which is now called Indian Wells Valley. Northern portions of this valley are controlled by missile impact and testing ranges of the Naval Weapons Center (formerly known as the Naval Ordnance Test Station) shown in Fig. 2. The entire area of the Station is closed to public access so that remarkable deposits of Rancholabrean animal bones and PaleoIndian artifacts have been protected and are available for scientific study.

The old lake basin is situated in the extreme northwest corner of the Mojave Desert. It is about 19 km east of the southern end of the Sierran escarpment face and includes parts of Inyo, San Bernardino and Kern Counties. The entire region is an extension of the Great Basin or Basin and Range Geomorphic Province, within which Indian Wells Valley covers an area of about 425 square miles. It lies between 35°30′ to 36°00′ north latitude, and 117°30′ to 118°00′ west longitude. Most of our work, including a mapping program and an intensive survey (Fig. 6) took place near the center of this valley, in a district comprising parts of sections 20, 21, 27, 28, 33 and 34: T 25S; R 40E as shown on the Ridgecrest Quadrangle Sheet 1953, United States Geological Survey. Today, Indian Wells Valley is a sand and gravel desert, low in rainfall but with a high water table, and is capable of supporting an extensive flora of specially adapted plants.

FIGURE 14. "The Lakes Country": Pleistocene lake systems of the Great Basin (after Russell 1889, opp. p. 269).

PLANTS

Plant communities vary with altitude from alpine zones through coniferous forests along high ridges of the Sierra Nevada to the west and grading downward into piñon-juniper zones and then to Joshua tree belts in upland valleys. Near the floor of Indian Wells Basin, creosote bush (*Larrea divaricata*) is dominant along the Sierran alluvials, giving way to members of the *Atriplex* family; salt bush, and desert holly as the valley bottom is approached. Around peripheries of the salt-laden playas and stretches of "puffy mud" (exposed beds of lacustrine clays), only saltgrass (*Distichlis spicata*) is able to survive (Fortsch 1972).

ANIMALS, BIRDS AND REPTILES

Animals seldom are seen in the valley due to crepuscular or nocturnal feeding habits; nevertheless, they are fairly numerous, particularly the rodents, which undermine sandy mantles with their burrows, making walking a problem. There are shrews, bats, hares, rabbits, ground squirrels, pocket gophers, pocket mice, kangaroo rats, a number of *Peromyscus* spp., mice, foxes, coyote, packrats, weasel, badger and skunk, bobcats, bighorn sheep and burros (the latter were introduced by miners and have now gone wild).

Indian Wells Valley is situated on a flyway. Therefore, its bird population is large all year and even larger during the migration seasons. There usually is a flock of snow geese to be seen wintering on the shrunken remnant of China Lake. Ravens are ubiquitous on the bombing ranges where we work and, due to their mischievous curiosity, account for the disappearance or displacement of small bone, stone and wind test samples. Other avian species include blackbirds, cowbirds, orioles, tanagers, towhees, finches, sparrows, mockingbirds, thrashers, robins, thrushes and bluebirds, gnatcatchers and kinglets, wagtails, waxwings, flycatchers, shrikes and vireos, warblers, flickers and woodpeckers, the horned lark, swallows, jays, crows and ravens, chickadees, titmice, nuthatches, wrens, sandpipers, avocets and stilts, phalaropes, gulls and terns, pigeons and doves, cuckoos, roadrunners, five species of owls, hawks, swifts, five species of hummingbirds, kingfishers, kites and eagles, osprey, falcon, quail and chukkar, rails and coots, plovers and killdeer, snipes and willets, loons, pelicans, cormorants, ibises, herons and bitterns, four species of grebes, ducks, geese, whistling swans and mergansers, (City of Ridgecrest, Conservation Element 1973.)

The Order Amphibia is represented by treefrogs and several species of toads. There are numerous reptiles including the Desert Tortoise, gecko, iguana, chuckwalla, skink, whiptail and nine species of lizards. There also are blindsnakes, boas and eleven other species of nonpoisonous snakes. The venomous snakes are represented by sidewinders and three kinds of rattlesnakes.

TOPOGRAPHY, SEDIMENTS AND SOILS

Indian Wells Valley is typical of structural basins in the Basin and Range Geomorphic Province, where alluvium-filled sinks alternate with northeast-southwest trending mountian ranges of fault origin. This whole configuration, viewed from a satellite, has been described as resembling "an army of giant caterpillars moving north from Mexico." Faulting is ubiquitous in the valley floor (Zbur 1963) and has influenced or even changed the topography of some of our surveyed sites. Stake 25, on a bench created by a short north-south fault, is an example. This fault appears to antedate deposition of most of the tools (which subsequently were covered at least once by the lake) and to postdate deposition of some of the animal bones. These are being exposed where rill rejuvenation, produced by the uplift, is incising back into the sediments.

Indian Wells Valley is surrounded by mountains, as shown in Fig. 2. Along the west side, the Sierra Nevada rises steeply to peaks of 6,000 to 9,000 feet in elevation. On other sides, the valley is bounded by the Coso Mountains to the north, the Argus Range to the east, and the El Paso Mountains and Rademacher

Hills along the southern edge. Alluvial plains slope gently from the boundary mountains toward the valley center. Alluvium derived from the high and steep Sierras extends nearly across the valley floor so that its lowest elevation is in the southeast corner near a Pleistocene outlet, which at one time connected Lake China and Lake Searles. This low basin contains a contemporary lake remnant (China Lake). To the westward, the gradient is extremely gentle (about 1.5 m of rise in elevation for each 2.5 km of distance); relief is low (2 to 5 m) and the shallow basins have become filled with down-washed, fine sediments, called salt pans or playas. These playas either are composed of level, hard clay or are encrusted with alkali, which rises to the surfaces after rains as a white efflorescence and is quickly blown away.

The age and history of this pattern of basins and low ridges in the east-central parts of Indian Wells Valley are of major importance for archaeological studies in the area. Our maps show a constant relationship between distributions of artifacts and the basin-ridge configurations—most camps being on higher ground, whereas hunting and special collecting localities are lower. Bone often has a similar, complementary distribution. There is reason to believe that key features of this landscape have a repetitive kind of permanence, unlikely as this may seem at first.

Far from being full/not full, Lake China bobbed up and down continuously: from brimful to nearly dry to many intermediate stages, during which time its broad valley was dotted with sloughs and ponds and was laced with sluggish drainages, which changed from one lake episode to the next as the ephemeral/stable landscape was revised. When the lake rose to full, everything was covered with a blanket of clays, fines and sorted gravels. As waters receded, older, harder surfaces of the mantled countryside were exposed in varying degrees to excision by wind (which carried away the fines) and then to water. Rill action slowly sculptured dissected beds around the peripheries of knolls. The center of the basin is in this condition today.

Directly underlying the present landforms there are alternating beds of alluvial and lacustrine deposits, which in some places reach a depth of nearly 6,200 feet (Zbur 1963). The upper five meters of these beds have been exposed by us in eight backhoe cuts distributed east-west over a distance of slightly more than two km. Stratigraphy in the trenches at Tower 5 and Stake 24 indicates that these two slightly elevated ridges also were somewhat higher islands many thousands of years ago. Portions of the present ridges, however, contain complicated stratigraphic records of cross bedding, channel cutting and channel filling, which may cause radiocarbon dates to appear out of sequence (see Table 2).

Two soils have been identified in the sidewalls of straticuts, made in 1973 and in 1974 (see Chapter 3). There is a weak, upper soil, and a strong lower one. Each of these is a time marker for a relatively static

TABLE 2

Reversed sequences of radiocarbon dates from samples of carbonaceous earth from backhoe straticuts, April 1973.

Tower 5, Trench C	Stake 24, Single	Stake 25, Trench A
Datum elevation, 2,181 feet	Datum elevation, 2,184 feet	Datum elevation, 2,185 feet
Level X 20,200 ± 675 ^{14}C yrs BP (GX 3126) A strong paleosol	Level X 12,500 ± 200 ^{14}C yrs BP A strong paleosol	
		Level VII 25,000 ± 750 ^{14}C yrs BP (GX 3122)
Level V 19,500 ± 725 ^{14}C yrs BP (GX 3125)	Level V 17,200 ± 300 ^{14}C yrs BP (GX 3118) A weak paleosol	
		Level III 30,500 +2,200 −3,000 ^{14}C yrs BP (GX 3121)
	Level II 11,330 + 550 ^{14}C yrs BP (GX 3117)	
		Level I 22,350 +1,030 − 930 ^{14}C yrs BP (GX 3120)

period during the restless history of Pleistocene Lake China. The soils developed as a weathering phenomenon on exposed surfaces, which were undergoing neither deposition nor erosion and probably were stabilized by vegetation.

These paleosols have been identified and dated (see Table 4) at Stake 1, Trench 3, A-1, and again (on the opposite side of the ridge, 100 meters distant) at Stake 24, Single, Levels X and XI. The strong, lower soil can be seen as a reddish-brown layer containing well-developed carbonate pods. The Stake 1, Trench 3, A-1 date is 10,275 ± 165 radiocarbon years (GX3442). A date on the second sample from Trench 24, Level XI may not be available before this manuscript is completed. The Trench 3, A-1 date is particularly interesting because this paleosol supported sandblasted flakes and also contained them. The flakes were deposited on the surface and lay there for a period of time long enough for them to become weathered (possibly many thousand years). After this, the lake rose again, high enough to cover the living floor with a mantle of clay, silt and gravel. More will be said about this area in Chapter 5 (a description of the sites). The means by which we were able to predict the probability of buried flakes occurring under the lacustrine gravels will be described in Chapter 3 in the subsection on "flaggy sandstone."

TABLE 3

Radiocarbon dates on carbonates: stratigraphic samples from backhoe cuts, April 1973.

Location	Level	Date
Stake 24, single	II	11,330 ± 550 ^{14}C yrs BP (GX 3317) on carbonate nodules, sandy
Stake 24, single	V	17,200 ± 300 ^{14}C yrs BP (GX 3118) on carbonate nodules
Stake 24, single	X	12,500 ± 200 ^{14}C yrs BP (GX 3119) on carbonate nodules
Stake 25, A	III	30,500 + 3,000, − 2,200 ^{14}C yrs BP on carbonate nodules (GX 3121)
Stake 25, A	I	22,500 + 1,030, − 930 ^{14}C yrs BP (GX 3120) on carbonate nodules
Stake 25, A	VII	25,000 ± 750 ^{14}C yrs BP (GX 3122) on carbonate nodules
Stake 25, B	II	19,150 ± 850 ^{14}C yrs BP (GX 3123) on carbonate nodules
Tower 5, B	II	11,100 ± 325 ^{14}C yrs BP (GX 3124) on carbonate nodules
Tower 5, C	V	19,500 ± 725 ^{14}C yrs BP (GX 3125) soil with some carbonate
Tower 5, C	X	20,200 ± 675 ^{14}C yrs BP (GX 3126) on carbonate nodules

WATER SUPPLY

The appearance of Indian Wells Valley today is in marked contrast to that of the past. During much of the Wisconsin stage of glacial advances and retreats, this valley has contained sluggish streams, marshes, lakes of varying sizes and depths surrounded by a much lusher vegetation. At present, an ephemeral lake, previously mentioned, occupies the southeast end, varying in

TABLE 4

Radiocarbon dates on soils and strata sampled by George I. Smith, 1974.

Locations	Dates	
Stake 1, Trench 2	5,975 ± 150 ^{14}C yrs BP (GX 3441) on calcareous earth	
Stake 1, Treanch 3,A-1	10,275 ± 165 ^{14}C yrs BP (GX 3442) on calcareous earth	Bracket a partially intact living surface
Stake 1, Trench 3,A-2	6,775 ± 260 ^{14}C yrs BP (GX 3443) on calcareous earth	Bracket a partially destroyed living surface
Stake 1, Trench 3,B	9,360 ± ^{14}C yrs BP (GX 3444) on calcareous earth	
Stake 1, Trench 3,C	2,465 ± 180 ^{14}C yrs BP (GX 3445) on calcareous earth	Marks a late retreat of the lake between 2 transgressions
Basalt Ridge, Site 1, Sample 6	10,800 ± 310 ^{14}C yrs BP (GX 3446) on calcareous earth	
DATE ON BONE 1972		
China Lake, T25S, R40E Sec 28 NE¼	18,600 ± 4,500 ^{14}C yrs BP (UCLA 1800) on ivory, mammoth no. 4	
DATES ON TUFA 1974		
Basalt Ridge	13,300 ± 150 ^{14}C yrs BP (UCLA 1911A) on tufa	
Basalt Ridge	12,200 ± 120 C yrs BP (UCLA 1911B)	

Note: These dates on tufa may be 500 to 1,000 years too old.

size and duration according to the amount of winter rainfall as well as the average of winter and spring temperatures. Most of the available water comes to the basin from eastern slopes of the Sierra Nevada (Kunkel 1969). Rainfall over the last 30 years has varied from 0.1 to 9.1 inches with an average of almost three inches.

During most of the year, water is available only at springs in the highland regions to the north and south or streams from the mouths of canyons emerging from the Sierra escarpment. Many of these streams are seasonal and disappear in summer. There are permanent springs in the country surrounding Indian Wells Valley: at Mountian and Birchim Springs northeast in the Argus Range; at Haiwee and Cole Springs in the Coso Mountains; at Little Lake and associated springs in a pass between Rose and Indian Wells Valleys; at Indian Wells on the edge of the Sierra Nevada; and at Sheep and Mesa Springs in the El Paso Mountains to the south. Many other inactive or intermittent springs are recorded in these areas as well. At present, the low area to the south and east of the valley indicates no signs of spring activity.

In the past, during periods of greater water supply—from local and upstream rains as well as from glacial melt water—Lake Owens, which lies 30 miles to the north, overflowed into Lake China through the Little Lake channel (Fig. 15). Within the water system containing Lake China, the overflow linkage of lakes was as follows from northwest to southeast. Furthest north was Lake Russell, Mono Lake today (Russell 1889). Mono flowed through Adobe Valley into the Owens River; then through Lake Owens and the Little Lake channel into Lake China; then into Lake Panamint, Lake Searles and Lake Manly in what is now Death Valley (Snyder 1964). These lakes were connected only during glacial peaks. At other times, each had its separate history controlled by its own watershed and precipitation.

During late Wisconsin stadials and interstadials, these lakes rose or receded frequently (Smith 1968, Fig. 4), and Lake Searles, the best documented lake in the Mono to Manly chain, changed from full to dry within a few hundred years (Fig. 16). In the case of Lake China, we only have information (which is not the best) on two penultimate high stands, measured at the Basalt Ridge Site as 2,234 feet MSL. At this point, we have two doubtful dates on tufa. Judging by these, the lake was brimful twice in rapid succession—13,300 ± 150 years BP (UCLA 1911A) and 12,200 ± 120 years BP (UCLA 1911B)—with a recession in between. After this, the climate seems to have warmed and dried; the water level sank, exposing a bay 7.1 m below the Basalt Ridge, and a soil had time to form at beach elevation by 10,800 ± 310 years BP (GX3446).

During stadials, therefore, the northern Mojave Desert was periodically a cold steppe containing a chain of pluvial lakes. Thus it was related, ecologically, to more northerly regions of the Great Basin, which were at times occupied by other great lakes systems—Lake Lahontan in Nevada and Lake Bonneville in northern Utah. In this report, therefore, the vast area of the Intermontane West is called the Lakes Country. It evidently provided an unusually favorable environment for early hunting-gathering peoples and the Rancholabrean fauna on which they preyed (Fortsch 1972). Plant communities also must have been different in their distributions; for one thing, there was more grass. We have not been able to get a pollen record from our site localities in the valley because the dry, alkaline environment does not permit pollen preservation; however, the faunal remains of large grazing animals indicate that this once was a savanna. The mammoths, camels, horses and bison all have teeth adapted to grinding dry grasses. It is, therefore, likely that at times in the past, water tables were higher and rain more frequent; lower levels of the surrounding mountains probably were forested thinly (as their summits are today). As the Great Basin climate warmed and dried after about 12,000 years ago, the lake (which probably was never more than 90 feet in depth) shrank to lower and lower levels, becoming increasingly saline. Climatic changes which engendered such diminishing of the water budget also must have had an effect on the regional biota: the plants, animals and human foragers. It is possible that attrition of their range placed the herbivores (particularly the larger ones) under pressure, leaving them open to disease and to human attack.

During late Wisconsin glaciation (22,000 to 12,000 years BP) the American midcontinent north of Texas was less inviting as a habitat than the Lakes Country in the Great Basin. It was covered by dark coniferous forests, aspen parkland, great stretches of dune sand to the west and a tundra strip further north (Wright 1970; Wells 1970). The most interesting question focussed on the animals is not *extinctions* alone, but the extinction of some species accompanied by adaptation and expansion of others.

THE PAST ENVIRONMENT OF LAKE CHINA VALLEY

This is an appropriate point at which to reconstruct a picture of the setting in this basin as it was at favorable intervals during late Pleistocene and early Subrecent periods, when ancient peoples and extinct animals found it to be an inviting (if seasonal) habitat. A number of large mammalian species ranged and fed there; and this fauna is recorded in our inventory of identified bones in approximately the following, relative numbers.

Species frequencies in surveyed localities:

1) *Tanupolama* ? sp ..... 2 fragments
2) *Camelops* sp ..... 375 ident. frags.
3) *Bison* cf *antiquus* ..... 187 ident. frags.
4) *Equus* sp ..... 126 ident. frags.

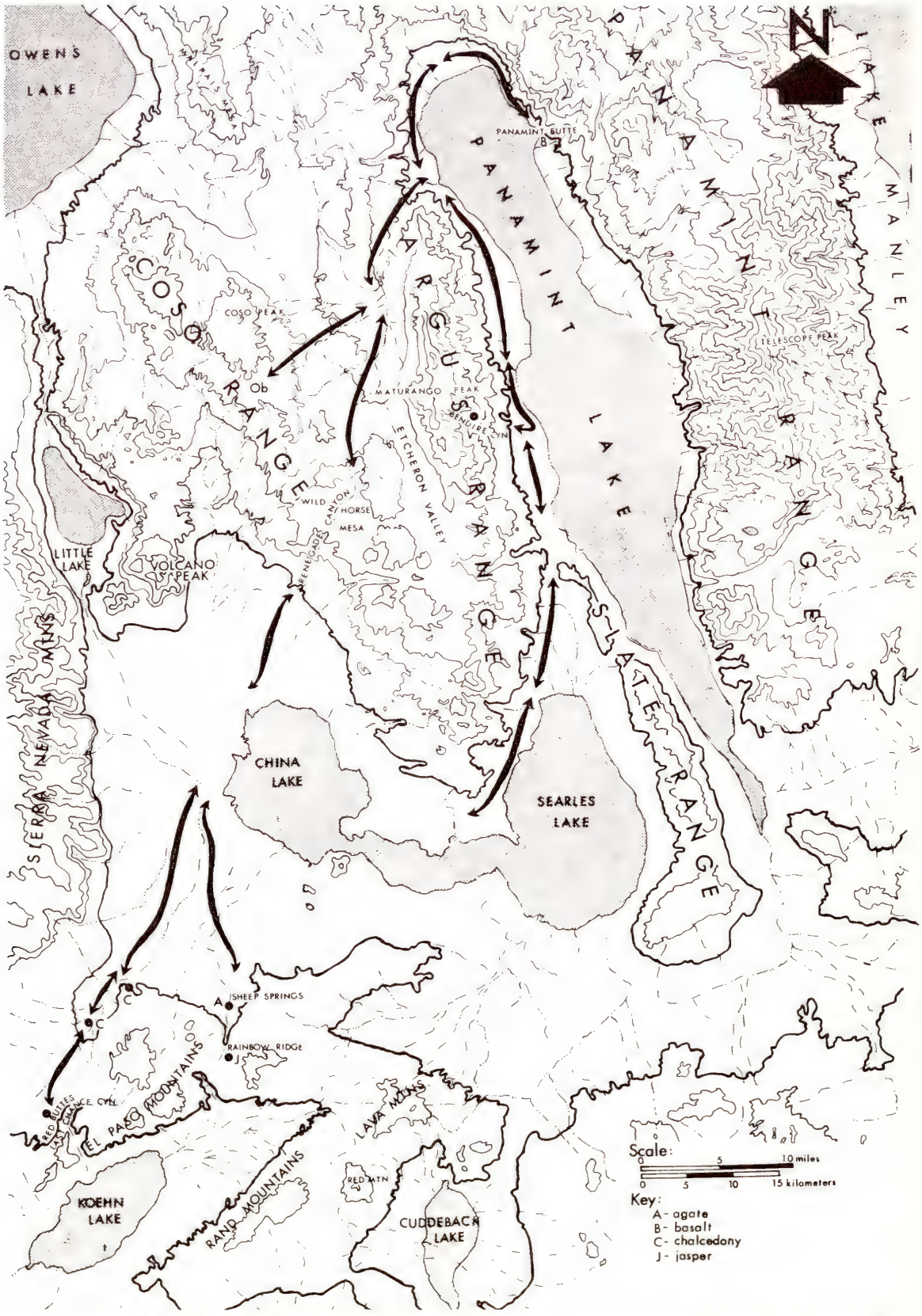


FIGURE 15. Map showing Pleistocene lakes and drainages, and migratory routes of foraging bands of people (heavy arrows). These wanderings were probably parts of seasonal rounds, like the recent Paiute (Davis 1965; Thomas 1973; Wheat 1967).

5) *Mammuthus* cf *columbi* ..... 42 ident. frags. (plus about 75 kg of unidentifiable pieces).

The Lake China Environment as Inferred from Faunal Habitats

The amount of faunal information retrieved from this dry lake area is amazing when the history of the bones is considered: they have all been buried and exposed at least once and some of them a number of times (a history which is true also of their companion artifacts). Most bone in this harsh area is fragmentary and all of it is mineralized. Nevertheless, the roster of species and their known habitats has much to say to us about optimal conditions of the lake and its surroundings. In respect to habitat conditions of Lake China, the Class Aves (Fortsch 1972:39–45) is particularly informative as follows.

Species	*Habitat*
Anas sp	Marshy areas with open water nearby.
Branta sp	Marsh nesting, near open water.
Aythya sp	Sloughs, ponds and lakes.
Oxyura sp	Marshy areas, shallow water and sloughs.
Grus sp	Shallow water wader in sloughs and marshes.
Phalacrocorax sp	Fresh water, deep enough to contain fish. *Nests in trees.*
Aquila cf *chrysaetos*	Perches high, *nests in trees.*

Grasslands

Dry land surroundings of Pleistocene Lake China are best reconstructed from known habitats and food preferences of the terrestrial mammals. The periodic existence of extensive savannas is demonstrated by the presence of Family EQUIDAE (a large and a small horse); Family CAMELIDAE (a large and a small camelid); Family BOVIDAE—*Bison* cf *antiquus;* and a number of specimens of *Mammuthus*. The relatively fine tooth plates of these (Columbian?) mammoths indicate grazing preferences rather than the browsing adaptations of mastodons or modern LOXODONTIDAE (Fortsch 1972:86).

Large predators such as *Smilodon,* the saber-tooth cat, and *Canis dirus* are informative mainly as they tell us that there were enough large grazers (and carrion) present to invite the attentions of a huge cat and a heavy-duty, hyena-like canid. The presence of coyote, *C. latrans,* brings into view another side of the environment: this grassland biota doubtless included rabbits, hares and small rodents.

Condition of the grassland must have been excellent at times, providing abundant fodder for large herbivores. As an example, the larger of the two Lake China horses is larger than the same species at Rancho La Brea (Fortsch 1972:76) due, perhaps, to superior feed. Last of all, a single fragment of deer bone (*Odocoileus* sp) further supports a premise that the surroundings of Lake China were savannas. Deer are forest edge browsers rather than grazers (although they eat some grass when it first sprouts in the spring). Scarcity of deer among our specimens, therefore, indicates a grassy rather than a brushy environment.

A Summary of the Lake China Environment

The habitats described above were ephemeral at Lake China, where lake level (and climate?) varied rapidly and extremely between 42,000 and 10,000 years BP (Fig. 16). These fluctuations probably placed the more specialized grazers, and the predators who followed them, under stress. Periodic attrition of the grasslands may account for part of the decimation of large animals, but not all of it. As an example, China Lake basin is today at its driest, yet an increasing herd of burros ranges there and another herd of 200 wild horses is thriving in the higher canyons where feed and water are adequate.

Variability of water supply to Lake China is shown both by our own stratigraphies and the better-dated sequence at Lake Searles, which received most of its water from Lake China. Only during optimal periods of climate and water supply, when the lake stood at an intermediate level, was the environment a supportive one as follows:

1) A shallow lake with marshy borders and (probably) numerous islands;
2) The rest of the valley covered with a healthy stand of tall grasses;

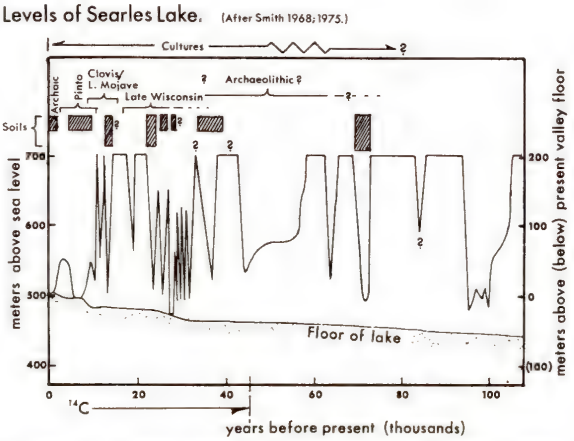


FIGURE 16. Fluctuations of Pleistocene Lake Searles (Smith 1968, Fig. 4).

3) Sloughs and sluggish streams;
4) Gallery forests along the streams or a few lakeside trees.

SITE DECISIONS AND HUMAN ADAPTATIONS

Within this setting, our plane table maps indicate that people lived on well-drained knolls along a grassland/marsh interface. During lakeside seasons of their annual round, these people had a Primary Marsh Orientation. Marshes are rich ecosystems (Storer 1953). During favorable climatic intervals, foraging bands of people used these resources for foods and raw materials, whereas the mucky swamps served as bog-traps for large herbivores.

Chapter 3

THE MAPPING AND TRANSECT PROGRAMS: TRENCHES, EXCAVATIONS, AND DATES

By Emma Lou Davis and Carol Panlaqui

Retrospect

There were parts of this desert, which we worked so intensively that we got to know them like our own hands and faces. Each windrow or bare spot became familiar in every state of light and changing shadow—long, long work that gradually soaked us with a feel for the dissected anatomy of this Pleistocene lake bed, its textures and inhabitants. In October, tarantulas roamed about looking for winter burrows. Their black and brown coats shone in the sun as they took their aimless pilgrimages across embedded artifacts and around the bones of mammoth or camel. When spring grew warm, lizards flashed out of our way as we trudged through miles of wildflowers—desert dandelion, mariposa lily, five spot and beds of blue phacelia. Water-sculptured basalt stuck out like the joints of a mummy buried in dry gravels. Butterfly shadows drifted across, pursued by the Davis' hound, Erica.

METHODS OF FIELD WORK

The China Lake Project is an interdisciplinary study in which a variety of field tactics have been used to coordinate several sciences. These are the fields of geology, palynology, anthropology, paleontology and studies of climate. All contribute parts of a mosaic picture, a picture of which time has left only patches: but this mosaic is our own prehistory—a story about the animals and plants, the landscape, weather and people of long ago. Who were the first Americans? Where did they come from, and how did they live?

Eleven types of investigation procedures were used during our five seasons in the field as follows:

1) The first survey, which was only a reconnaissance.
2) Intensive test surveys of 305 m squares, using a theodolite instrument (Fig. 17). The layout of squares is shown in Fig. 6.
3) Long transects A and B (Fig. 3).
4) Backhoe trenches or stratigraphic cuts.
5) Excavations.
6) Field investigations, soil tests and laboratory analyses of samples by George I. Smith in his capacity as geological consultant.
7) Palynological coring and laboratory analyses by Peter Mehringer, cooperating paleobotanist.
8) Radiocarbon dates on stratigraphic samples taken by Davis in 1973 (see Table 3).
9) Radiocarbon dates on samples of soils taken by Smith 1974.
10) Coring, analysis of lacustrine sediments, pollen counts and radiocarbon dates at Little Lake: Mehringer 1974.
11) Identification of the fauna by Fortsch.

At a later time we will add mathematical correlations, regressions and comparative scores suitable to the particular collections and situations of this project.

Several of these methods already have given us information, including:

1) Relation of artifact-bearing sites to lake levels (Fig. 4);
2) Distribution of bones;
3) Gross categories of artifacts and criteria most useful in grouping them;
4) Actual geographic distributions of these various tool categories;
5) Former state of the locality (slough, pond margin, ridge or lakeside);
6) Intensity and frequency of use by humans;
7) Men's and women's work areas;
8) Sources of artifactual stone and the significance of varying percentages of these raw materials on different sites;
9) Relation of lacustrine and alluvial beds;
10) Soils;
11) Datable materials and radiocarbon dates;
12) Predictable locations of buried artifacts;
13) Clear vs unclear or negative associations of PaleoIndian artifacts with the Rancholabrean fauna.

FIGURE 17. Carol Panlaqui working with the theodolite at Stake 13.

PROCEDURE 1: THE LAKESHORE SURVEY (RECONNAISSANCE)

This initial reconnaissance was based on a vague and untested postulate; namely that during the Wisconsin Pleistocene the lake was full and people (if any) lived around the shoreline, particularly at those locations where a stream intercepted the lake margin. We found no bone or cultural material around the high shoreline except much later at the Henry Site, described in Chapter 5. We have since learned that the original assumption was naive. People and other mammals used this lake valley when it was at its best—after flooding and during recession of the water.

PROCEDURE 2: INTENSIVE SURVEYS AND MAPPING

The first reconnaissance was dropped when half-completed for several reasons; it was minimally productive, it was organized loosely so that we had no control of artifact provenience and no adequate records. Most importantly, the discovery of Mammoth no. 1 with a chopper among the bones and other artifacts at no great distance made it appear wise to change both our area of focus and also our methods. *It was essential to know the exact provenience of each specimen and to have this information recorded on a map.* To this end, a tighter program of interdisciplinary research slowly was developed.

Clayton Panlaqui, who had professional experience as a surveyor, set up a system of 23 "stakes," each on the summit of a slight elevation from which we commanded a view of at least 500 feet (152.5 m) in every direction. Eventually each stake became the center or instrument station for a square 305 m on each side (Fig. 6). In turn, each square was subdivided into four quarters: A B C D or I, II, III, IV.

Conventions.—The work area included Indian Wells Valley; Little Lake and the deep gorge connecting Little Lake with the northwest corner of Indian Wells; parts of the Argus Range; the Coso Mountains; Wild Horse Mesa; and the north basin of Panamint Valley (see Fig. 2).

To locate this work, we used two interlocking systems: 1) USGS Quadrangle Sheets 15″ Series and 2) the Naval tracking towers, askania astrodomes, camera stations, bench marks and any other highly visible landmarks. The Quadrangle Sheets we used are the following: Little Lake, Mountain Springs Canyon, Maturango Peak, Trona, Inyokern and Ridgecrest, Panamint Butte. All these maps give "north" in two versions—magnetic and true (which varies with declination). Our stake maps, however, use neither of these but only an approximation—"northward"—and for a practical reason. At each stake it was necessary to orient the northward point close enough to be identified within our immediate Quadrangle Sheet or to a Navy application of it (a copy of the sheet with an overlay showing the orientation features of the missile impact ranges). Most of our stake maps are oriented toward tracking tower no. 7 because it was convenient.

Because our mapping has been tied in with coordinates

of the Naval Base system such as tracking towers, etc., measurements are in feet or in miles, which are then (usually) translated into metric equivalents. However, of necessity, this report uses both the metric and the English systems of measurement.

Flagging.—During subsequent mapping operations, everyone did a lot of walking about—to and from cars, etc.—so each worker was given a pocketful of box nails and a length of orange flagging tape. When a bone or artifact was seen, it was marked with an orange flag stuck in the ground. Later, during mapping, the flag and specimen were picked up; meantime, the desert blossomed as the rose.

Mapping.—Two instruments were used—a theodolite for long shots or alidade and plane table under most circumstances. Each had its advantages and shortcomings. The theodolite is a more accurate instrument with higher magnification (inverted); its disadvantage is that results of each reading are a distance and an angle, which must later be converted to a position on a map—a two-step process. An alidade has a lower power glass but is mounted conveniently on a calibrated straight edge, which can be freely rotated around the center point on a levelled drawing board. In this way, you build your map as you go. Each plot can be entered directly on the map background together with its sequence number and classification (bone or stone), (Davis 1975). In addition, major topographical features were identified and mapped so that we could relate, by maps, these features with bone and artifact distributions.

Bones, artifacts and flakes were spotted and collected in the following ways: a surveyor with a stadia rod worked each quadrant, pacing along a line as straight as possible and about four feet distant from the previous track, easily seen as a guide because the surveyor dragged the rod along behind. These drag marks show well in Fig. 17, directly behind the instrument tripod. When a specimen was found, the rod person shouted or signaled "bone" or "artifact" and requested a distance reading. After this, the foot worker sat down and made out an 8″ × 5″ edge-punched card with the following information:

1) Drawing of the top view.
2) Drawing of the side view.
3) Class of the object.
4) Probable use(s)—see Chapter 4.
5) Material.
6) Direction, distance and materials of closest flake clusters.
7) Stake and quadrant.
8) Distance and approximate direction from Stake.
9) Date.
10) Name of the worker.
11) Type of topography (playa, sand, drainage, gravel windrow).
12) Number of artifact or bone.

A separate flake card was made out for each quadrant as a whole and each flake was coded according to its material to determine the presence or absence of meaningful clusters or correlations. Ct was the code for chert; C for chalcedony; O for obsidian; and B for basalt. We figured that the amount of walking involved in this work was considerable. If we made 200 traverses per survey square, then we walked the equivalent of 64.4 km on each Stake. Since about ten stakes were completed, approximately 640 km were covered on foot.

This system was not fully evolved until we had finished work on stakes 7, 8, 9 and 22. In the beginning we had no instrument at all—we paced or estimated distances, flagging specimens as we walked. Later, Davis worked Stake 8 NE using a cross of N-S and E-W reference lines (which were flagged at five-foot intervals) and a Brunton compass. The Navy loaned us first the theodolite and then a plane table with alidade; later, because such large quantities of flakes were found in some areas, a system of special cards for recording flakes was adopted and the mapping program continued in a satisfactory manner.

There are now about 4,000 cards in the field work card collection. In the field, when there was no time for prolonged consideration and when we relied on the varying outlooks of many workers, the recording of artifacts was, naturally, uneven and many were overlooked, ending-up temporarily in the "flakes" bags. Some of these flakes were later reclassified during the 1974 preliminary inspection by Davis. Many more will doubtless be recognized in the future when a more didactic analysis of this collection is undertaken, together with studies of the lithology and sources of the various rocks.

The artifacts: storage and code numbers.—All artifacts are stored in the archaeology laboratory at the Natural History Museum of Los Angeles County. They are bagged in labelled bags according to stake and/or quadrant, with the exception of specimens used for the photographic illustrations. These specimens are in a special collection, mostly in color-coded bags, sorted by hypothetical culture/chronology.

Code numbers are as follows: 1 B-52 would mean "Stake 1, Quadrant B, no. 52" as shown on the original plane table map. These field maps must be coordinated with all tool studies.

PROCEDURE 3: LONG TRANSECTS A AND B (FIG. 3)

The intensive test surveys outlined above were confined to a small area, were detailed extremely and, therefore, tended to be myopic. A corrective for this was needed to have an overview of the valley as a whole. Long transects A and B were designed for this purpose, and both were completed during the winter and spring of 1973. They were long traverses about a quarter-mile

in width followed by selecting a compass heading and working it with two vehicles and relays of walkers. The walkers would walk one-half mile then pick up the lead vehicle and drive one-half mile, then walk again while the other group also alternated driving a stretch and walking a stretch. In this way, we covered a lot of territory fast without anyone becoming too tired.

Transect A originated at tracking tower no. 6 and passed across a great distance of sterile country within the first five miles: only a single site was found (a blowout eastward from Charley Range headquarters). After hours of slogging through sand and gravel, a site concentration was a welcome diversion. By this time, the van arrived with food aboard, a warm sun had burned away the morning frosts, Jim Williams had set up his camp barbecue, and we enjoyed a weiner roast with coffee and apples—in our shirtsleeves, too.

This was Transect A, Site no. 1, a small blowout surrounded by low, gravel-covered slopes. The distributions of cultural materials in this locus had something to say to us. Jasper, chert and chalcedony flakes were concentrated on the north edge and appeared to be eroding out of the gravels. The rest of the flakes all were obsidian and were different both in technology and in distribution; they were very thin and light. Therefore, the wind had picked them up and blown them for some distance upslope from the downwind side of the blowout, so that they were more scattered than the silicate pieces. Throughout our work in various localities we have noted instances where artifacts have been moved by wind action, or by rill action, and other circumstances where there has been only slight displacement. Total artifact weight, amount and orientation of flat-plate exposure, accessibility to wind and/or water and gradient of slope of the supporting surface are the determinants of artifact shifting. In no case, however, do we observe any evidence of long-range transport. In order to see what actually happened to exposed stone, two tests were made to determine shifting of sample pieces of rock: one test was at Stake 25NW, the other at Stake 13. In each case, the test specimens were shims or chunks of steatite, weighed in grams, marked and painted black at one end, white at the other. After a year of exposure, all artifacts had moved slightly, *but not in the same directions.* Evidently a number of variables control artifact shifting as suggested above.

After Site no. 1, Transect A was interrupted for a distance of several miles by a prohibited area surrounding Charley Range headquarters. These areas are a great detriment to scientific investigations and should, in time, be sampled; they are rich in cultural deposits and probably faunal remains as well. To the west of Charley Range, the transect was resumed, continuing over many more sterile miles until we reached the southern end of the Owens River Gorge and turned north toward Little Lake. (See Fig. 3).

Here, upstream from the old delta, we entered a different world. We found no PaleoIndian sites, no bones of extinct animals, but the shelter of the basalt cliffs—a quarter-mile apart from wall to wall—appears to have been a seasonal refuge (perhaps in winter and in early spring) for later groups. These were small, migratory bands of people who used handstones, rock-slicks and mortar holes in the bedrock for processing plant foods. They ground or pounded these foods with special, regularized motions quite different from the irregular bashing employed by PaleoIndians.

Rock art.—At some time in the past of this country, the transitory inhabitants began making petroglyphs, which they ground or pecked into vertical faces of the black basalt. Styles of this form of communication seem to commence with "pit and groove" glyphs,

FIGURE 18. Abstract and anthropomorphic petroglyphs near Lower Fossil Falls.

rare in numbers and heavily patinated. This is presumed to be the most ancient of Great Basin petroglyph vocabularies (Heizer and Baumhoff 1962:311). A sequence of styles continues with anthropomorphs and elaborate abstractions like those shown in Fig. 18. Further downstream, near the Lower Fossil Falls headwall, a number of sheep are depicted. Bighorn sheep have been proposed as a form of hunting magic associated with trails (Heizer and Baumhoff 1962:218) on no better grounds than supposition. Recently, a scholar who has the great advantage of being half-Indian has suggested that the sheep were a commonly accepted surrogate for the concept of "quadruped." This abstraction carries a specific message of motion or direction (Martineau 1973:11). Martineau's book, *The Rocks Begin to Speak,* is worthwhile reading for anyone interested in the rock art of North American Indians of all tribes. The author used his knowledge of the pantribal sign language and of cryptanalysis to decode many petroglyphs and to present an extensive system of ideographic symbols. These glyphs have narrow ranges of meaning, demonstrating development toward a written language. Those shown in Fig. 18 are deep within the Weapons Center testing ranges and, therefore, seldom are seen.

Transect B was a lucky accident, the result of a temporary interruption of work on Transect A caused by unusual rains. When the ground became too wet, we could not venture far from roads. Therefore, on a damp weekend late in the winter, we found ourselves rained out and had to make alternate plans quickly. The vicinity of a bladed road called Centerline seemed the best choice. We knew little about the area and the road assured us escape should threatening clouds begin a new burst of showers, which could turn the unstable clays into a quagmire. Sites Tr. B-1, B-3 and B-4 will be treated in detail in a later chapter discussing all the sites (Chapter 5).

The sites along Transect B indicated that people of all cultural stages (from the Core Tool Tradition through Clovis to Pinto) had used the lakeshore for purposes other than hunting. Only two fragments of bone, of a size suggesting deer or antelope, were found during this part of work on the long transects. From this we infer that the lake offered many other attractive resources of both food and utility products such as waterfowl, eggs, muskrats, roots, tubers, cattail leaves for mats and rafts and fibres for cordage. What did the mammoth hunters do when not hunting mammoths? These Transect B sites were evidently available for use at a number of times during human occupancy of the valley. Since the lake had to have been very low—not above the 2,160 foot level—for people to camp and work in this locality, it is reasonable to assume that Lake China was extremely variable in its depth and extent. It rose or receded frequently. There probably has scarcely been a place in this flat basin that was not a shoreline at some time or other.

PROCEDURE 4: BACKHOE TRENCHES, 1973 AND 1974

To understand the sequence of lake episodes, we needed stratigraphic exposures, and since these rarely are found as a result of natural causes in Indian Wells Valley, we resorted to use of a backhoe. During April of 1973, six such cuts were dug to a depth of 3 to 4.5 m as follows: trenches A, B and C at tower no. 5; a single trench at Stake 24; two trenches (A and B) respectively northeast and northwest of Stake 25. Ten samples of carbonaceous earth were sent to Geochron Laboratories for dating. The results are both interesting and puzzling, since the dates frequently are reversed. This may have something to tell us about both kinds and degrees of carbonate contamination in these stratigraphies. The entire series of dates are listed at the end of this chapter. The inverted sequences at Tower 5, C; Stake 24 single; and Stake 25, A are shown in Table 3. At present we do not understand these phenomena. Complexity of the sedimentary beds is shown in Fig. 19, the south headwall of the Stake 24 single trench.

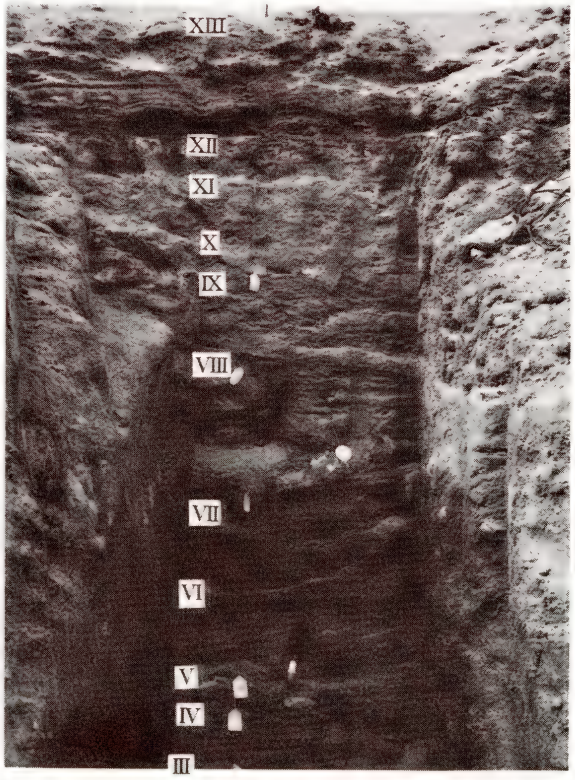


FIGURE 19. Complex stratigraphy in the south headwall of Stake 24, Single. At the top are lacustrine, sorted sands (probably 2 different deposits). Beneath them, between the last 2 marker tags is a strong soil. Near adjacent Stake 1, this paleosol both supported and contained small percussion fabricated finishing flakes. It has a (questionable) radiocarbon date of 12,500±200 years BP (GX 3119).

Two more shallow trenches were made at Stake 1 in the spring of 1974. They amplified information about the "flaggy sandstone" outcrops, related them to a strong fossil soil and supplied material for dates. This work completed our first seasons of investigations and began tying some loose ends together. The flaggy sandstone discoveries are discussed in the next section.

The "flaggy sandstone" problem.—Once the stratigraphic complexities of Lake China sediments had been broached with backhoe cuts, a question, long unanswered, was raised anew: why were many of the artifacts and most of the bone on our stake maps found in association with a curious formation which we called "clinkers" or "flaggy sandstone?" George Smith had not been able to identify this material in the trench walls with any certainty; therefore, some different means must be devised to recognize it when it was still in the matrix of earth. This new tactic quickly led us to a vantage point in our research, a point we had not reached previously, where it became possible to make cautious predictions about the occurrence of buried artifacts. Before this, the project had been operating in the dark.

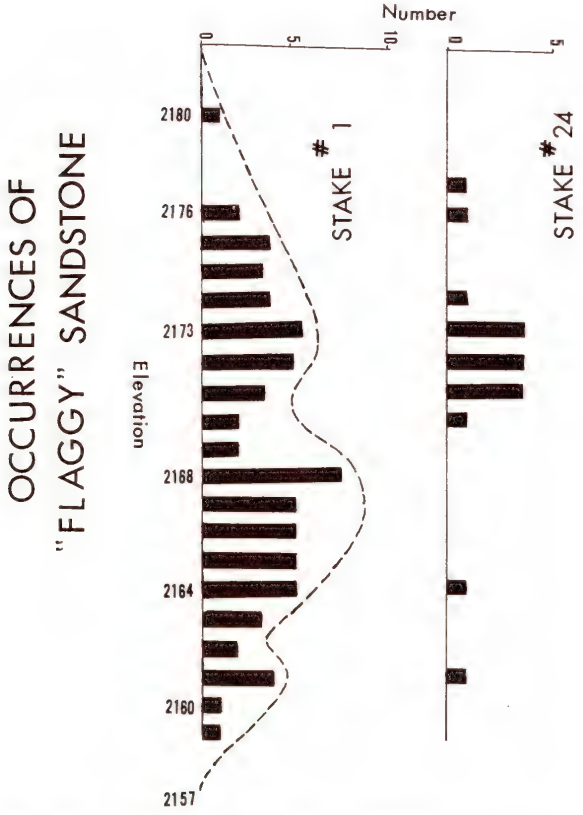


FIGURE 20. Elevations of "flaggy sandstone" at adjoining Stakes 1 and 24. While soilcreep and other disturbances have doubtless altered some of the configuration of these small deposits, nevertheless there is some suggestion of trimodal curves. It will be worthwhile to look for deeper deposits of a similar nature.

A first step into the light was to learn as much as possible about the origin and distribution of the flaggy sandstone material, which usually was found in little concentrations. Therefore, we set up the plane table once more at stakes 1, 24 and 8, adding locations of sandstone outcrops to the original field maps. The sandstone clinkers have been described by Smith (unpublished report 1973) as "flaggy, brown, calcareous sandstone found in . . . outcrops." The outcrops occur at several different elevations (Fig. 20) with concentrations outlining a trimodal curve. While surveying, we noticed that there are different kinds of flaggy sandstone, associated with different localities and elevations. This may be of no significance, or it may be a clue to existence of other soils.

When maps of stakes 1 and 24 were joined together (Fig. 21), the configurations were exciting. The distributions of flaggy outcrops and bones showed the following characteristics:

1) Bone at both stakes followed arcuate patterns resembling shorelines. (Bones are represented by black circles.)
2) Sandstone outcrops described a portion of a circle around Stake 1 and looked like the rim of an eroding stratigraphic unit.
3) These outcrops were associated with unusually dense concentrations of flakes and artifacts (see Fig. 21, "Key") south and southwest of the stake.
4) Therefore, there should be buried artifacts, lying on or in a bed which also contained the sandstone clinkers—and this bed should be still buried under sand of lacustrine origin. Such a sand probably covered the Stake 1 knoll and extended into Stake 24.

If this prediction checked out, it would explain several phenomena—the lack of artifacts on *top* of the knolls and their abundance around the eroding perimeters. The hypothesis was an easy one to check—draw a compass heading line from Stake 1 through any of the stone concentrations in squares B-2, B-3 or B-5, and put in a stripping excavation near the edge of the sand. Trench 2 (Fig. 21) was on a bearing of 196° magnetic from the stake and measured 3.05 × 4.6 m. The cover of coarse sand was shovelled into a wheelbarrow for removal and every third barrow was screened, ¼-⅛ inch. No artifacts were found until a contact between loose sand and cemented gravel was reached. This gravel marked the surface of a paleosol. A few finishing flakes of various rocks (chalcedony, agate, obsidian) were found on top of this fossil soil or embedded in it. The flakes were small (about 1 cm in length) and were sandblasted. They had evidently lain on the old camp surface for a length of time sufficient to weather them.

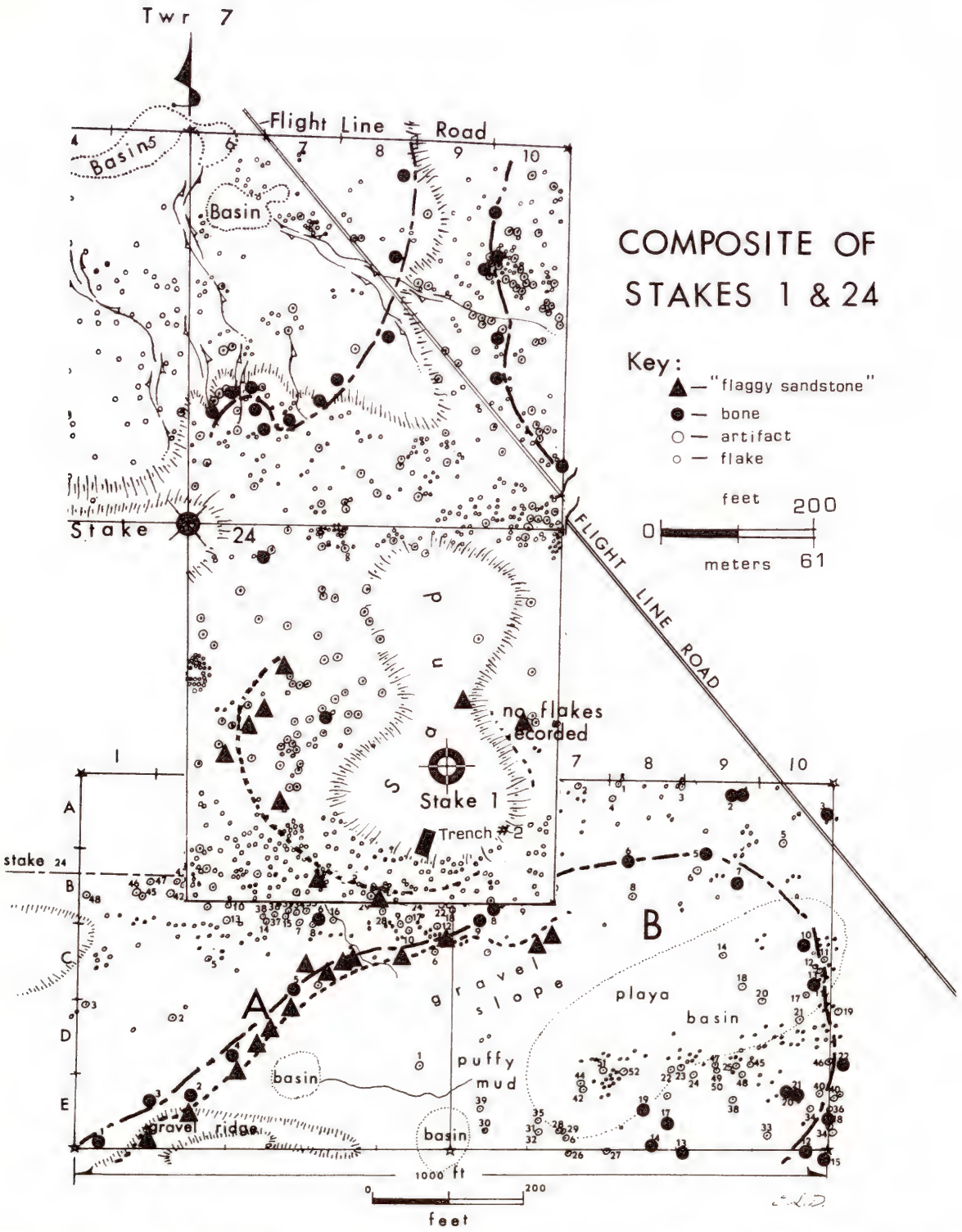


FIGURE 21. Composite map of Stakes 1 and 24, showing close association of artifacts and animal bone with the flaggy sandstone concentrations, and the paucity of all three on top of the sterile sand.

On this basis, it seems likely that other sites in the valley may also be partially buried under similar circumstances, where a sterile mantle of lacustrine gravel is surrounded by an erosionally exposed ring of artifacts. Therefore, the mapping program had produced not only horizontal stratigraphies of widely distributed artifacts (Rogers 1939), but also vertical ones with at least some predictable relationship to the oscillations of Lake China. In the spring of 1974, two more backhoe cuts were made at Stake 1 in connection with the hand-dug Trench 2. Samples were taken from fresh exposures of the paleosols, and also from a new site area called Basalt Ridge. Dates are given in the next section.

Dates.—Twenty radiocarbon dates on various carbonaceous substances are listed in Table 4. All should be treated with caution because of the possibility of contamination by other carbonates. As an example, the two dates on tufa came back with a note from the laboratory saying that they may be 500 to 1,000 years too old.

Excavations.—None of our spade work amounted to more than exploratory trenches and pits, since the mapping program and transects had priority during this preliminary research; however, hand excavations (in addition to the backhoe trenches) were undertaken when indicated. Both the theories and procedures of these excavations changed over time as the result of more experience in working over a very wide area and of greater familiarity with the complex nature of Lake China upper stratigraphies—those which supported or contained the stone detritus of PaleoIndian campers. These stratigraphies are discontinuous, expressing the ephemeral character of eroding/aggrading landscapes, which were subtly resculptured over time, yet seem to have retained certain key features (ridges and basins) over at least the past 15,000 years. As an example, artifact distributions seem to continue in general association with major landforms although the tools appear to represent secular changes, both cultural and technological. Over the millennia, people liked to camp near water, on a well-drained high point with an overview of the hunting ranges (Judge 1973; Judge and Dawson 1972). They also gathered eggs in season, hunted muskrats or waterfowl, and made extensive use of willows for light equipment. Water plants were a source of foods and utility materials. Our maps show a constancy of association between activities and topography clearly indicating the presence of water.

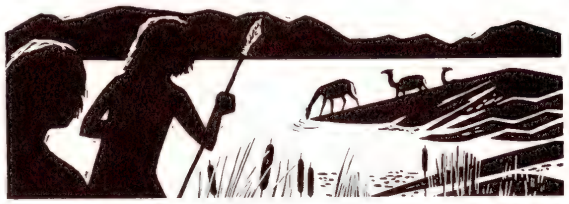
As we learned these relationships, our excavation plans became more open and improvisational. Instead of digging a random sample of pits in a 25 × 25 universe, the orientation changed to viewing a larger sector—a whole slope, shore and basin complex—as a universe for testing. Pits were mapped in at different elevations, azimuth and distance from the instrument (as at Basalt Ridge). For speed, pits, if they were scattered singles, were made round as at Basalt Ridge.

In another instance (at Stake 1 and at Trenches 1 and 2), our field maps, like a water dowzer's rod, dictated the exact location and compass heading of excavation probes where buried artifacts lay, and what the pattern of deposition had been. All these examples are discussed later in the site descriptions (Chapter 5).

Chapter 4
STONE TOOLS, THE ACTION UNITS

By Emma Lou Davis and Carol Panlaqui

BROKEN KNIVES



An archaeologist walks up the crown of sand at Stake 25 and sits down. All about lies the desert basin of dry China Lake, a shallow valley ringed with mountains and volcanoes, slotted here and there with passes. Southward are the El Paso Mountains and Rademacher Hills, where PaleoIndians crossed north and south between Lake Koehn and Lake China, stopping to collect the raw material for their stone toolkits: chalcedony and jasper at the head of Last Chance Canyon; Sheep Springs agate and motley jaspers from Rainbow Ridge (a rockhound's dream). North there are red and black volcanoes flanking Wild Horse Mesa, an avenue for travellers from Owens or Panamint Valleys, and there is Petroglyph Canyon, a message center where generations of folk whittled their communications into the cliffs. To the west is the Sierra Nevada Range. In the foreground lies a bench of gravel between the instrument station and a long, sunken playa.

With eyes closed, the scene dissolves and other images overlap. The Sierra is a little lower. Snow glistens in the canyon heads although it is April, and a strong piñon-juniper forest covers slopes down to the alluvials. Close by, a scrubby juniper can be seen among sage and grasses on the lip of the bench, bordering a long area of pond, swamp and cattails (the playa area of today).

Two men sit inside a low half circle of sagebrush branches stuck into the thin soil, forming a combination windbreak and lookout blind. These people divide their attention between an occasional scan of the western pastures for a sight of game, sporadic gossip and handiwork. One of the two lookouts is a thin youth; he has recently joined with a young wife and is rolling cordage for her to use in twining a carrying bag for eggs and foods out of the marsh. He picks strands of fiber from a hank, smooths them with a worn, irregularly-notched flake (one of his wife's shredders), strokes them together with a quick, delicate pass of his roughened fingers and rolls them into an S-twist between palm and thigh, splicing in more strands as the line grows longer.

The second man is older, perhaps 30. His brown features are beginning to look rugged; crowsfeet are etched at the corners of his eyes from a lifetime of squinting into the sun. He sits half naked in the spring light, a fur robe beneath him and across his legs. A few twigs (for melting resin) smolder between him and his kinsman. This older man is re-arming a valued instrument, the foreshaft/handle of a dual-purpose hunter's tool useful either as the tip of a thrusting spear or as a butchering knife. Long, thin and finely made, these stone tips are the Sheffield cutlery of the American Paleolithic, good for both killing and dismembering large game. Now this one is broken and only the snapped-off base remains set in its bone foreshaft. That last camel was a tough one. They broke several good knives prying too hard, trying to sever its head while the women set about skinning out the rump end.

The hunter glances at his ruined knife. He dumps out the contents of a hide work sack, selects a sharp flake and cuts the lashings holding stone and foreshaft together, works the stone free from its anchoring gum and drops it on the earth. Made of tan jasper, it blends with the soil. He stands up and walks toward the pond, limping a little for the first step or two. That knee again. Then trotting down the bank, he goes to a spot at the water's edge where a stick protruding from the mud marks a cache. Closeby, the camel hide can be seen, buried in the ooze until the hairs loosen. The hunter scrabbles with his hand beside the stick and retrieves several pieces of his stash of choice stone, shaped into long, rectangular blanks, ready to be used as knives, but not yet modified as points. Rubbing with his thumb to clean the surfaces, he selects a fine-grained blank of yellow chalcedony; he sticks the other stones back into the mud, sloshes the yellow one off in the cold water and takes it back to his windbreak.

Far down the pond, quacking and beating of water are heard and a flight of ducks arrows by on the rise. The men listen and exchange remarks: a gathering party must be working the marsh . . . with such swarms of

ducks and brant, geese and seagulls, there should be eggs in camp to eat with root cakes—a change from dried camel. Holding the yellow chalcedony blank in one hand, the old hunter uncovers his left knee, lays a folded pad of hide on it, picks up a battered hammer of antler beam and carefully finishes a replacement for his hunting/butchering tool. He grinds the rough edges smooth and with rapid, pulling clips of the antler, he shapes it—one edge slightly curved for cutting, the other edge straight with a faint shoulder to prevent the tool's backing into its haft under pressure. He thins the base, leaving a nipplelike platform in the center (shaped with pressure flaking and a sharp antler tine), grinds off the burr, turns the piece 90° on his knee pad and drag/clips two paper-thin longitudinal flutes from one side and three from the other side. His motions are deft and economical as he seats the new implement into a two-piece bone socket, melts resin around it with a glowing twig and binds it tightly in place with damp sinew fibers from the camel's spine. Grasping the foreshaft/handle, the hunter gives it a snap, testing for security. The yellow chalcedony tool shines with a burnish. He gets up from his robe, speaks to his companion, "Turn a little so you can see better, I'll be back," and walks naked over the rise to camp—two low-crowned huts of branches covered with hides and cattail mats. Wreckage of the camel lies around and thin slices of jerky are drying dark red in the sun. The hunter bends to turn the ones that are curling and as he does so, his foot kicks a fragment of stone tool out of the dry soil. It is another knife/point base, made of pink chalcedony but otherwise nearly identical to the piece he just discarded. The hunter dropped it three seasons ago, the last time they were there. That was the lucky season when they stampeded those two mammoth cows and the hysterical calf.

This "establishing shot" is introduced, like a passage in a documentary movie, to invest weathered stones on museum shelves with some shadow of human reality. The three knife/points are:

Stake 25-Ka-1 (tan jasper)

Stake 19SW-Quad I, 1 (pink chalcedony)

Stake 13-Quad C-52 (yellow chalcedony)

The description of the hunter's manufacturing process is adapted from Judge (1973:168); the idea of a compound bone foreshaft is taken from Lahren and Bonnichsen (1974:147).

The Age and Relative Position of Lake China Artifacts

This sample of stone tools comprises almost 20,000 pieces, representing many episodes of site-use, a number of cultures and phases, and a span of time which we consider to have a depth of at least 45,000 years. This is an arbitrary figure—an estimate based on the presence within the sample of a number of distinctive toolkits. They differ in pattern, preference of material, task capability and they differ consistently in degree of chemical/physical weathering. Fortunately, we have discovered means for testing their ages.

Those artifacts from Lake China sites that are described in the following chapter appear to have far greater antiquity and techno/cultural diversity than we had anticipated. Their age and variety cannot be crowded into such familiar packages as "Pinto," "Clovis" or "Lake Mojave" (though all of these are also present in quantity). Instead, artifacts of the Lake China sample suggest such unexpected activities as basketry or wicker-work, protomilling and root shredding on the part of their Upper Paleolithic owners. The scientific legends of Macho "big-game hunters" who ate only mammoth are not supported by the Lake China inventories. PaleoAmericans ate or used everything.

We were particularly surprised by the impression of age conveyed by some of the artifacts. These have been lumped together under the name "Core Tool Tradition," presumed to have flourished in South America between 25,000 and 15,000 years ago (MacNeish 1971). The term and its companion "Late Wisconsin Cultures" in our taxonomy, have been cited by one of our reviewers (Ruth Gruhn) as "inelegant." She's right. In time and as we learn more, far better terminologies supported by established Phase sequences will be devised. However, we have barely started a search for PaleoAmericans. A decade ago this goal was blocked off for a time by impressive literature of a "Clovis Conquest" of the Americas, buttressed by the fact that Clovis was supported by a dozen dates on 12 Dead Mammoths, whereas views of the more adventuresome appeared to float on guesswork with both feet firmly planted in the air. The relatively recent Clovis mammoths conveniently were datable by radiocarbon measurements whereas not a single "earlier" site was ironclad enough to resist the corrosion of skilled and well-aimed criticism. This situation is beginning to change, slowly. Sites with both dated and estimated ages of various levels of veracity are cited in Table 10. Those with ^{14}C dates probably will be able to fly through the flack. Those with racemization dates will remain subject to observation until more is known of the limits of this method. Sites (like most at Lake China) will have to remain beyond the Pale for a time longer if they rest on guesstimates. However, this, too, will be resolved by increased and relentless efforts on the part of many workers (like ourselves) who have chronology problems. As an example, we now know that archaeological sites in the Lake China basin were related to paleosols. Therefore, testing our propositions about antiquity of these sites has become a clear problem in the geochronology of that basin—the late Wis-

consin/Subrecent sequence of high-water, low-water and pedogenesis.

Should this proposed work substantiate the presence of valid Archaeolithic or Core Tool phases in Lake China valley, it will also lend such anomalous inventories greater credence throughout the New World; in New York State (the Timlin Site), Mexico (Tula River Site), in Lake China and Lake Panamint valleys (see Table 10). The inventories vary from site to site, but the following tools appear to be ubiquitous: choppers; chopping-tools; small work tools with a blunt projection, which Aldrich (1972) calls "dog-faces"; round-end scrapers; large, chunky beaks; spoke-shaves and, most important—*cordiform knife/points*. These are diagnostic and may be in the direct line of tool designs leading to Clovis . . . some are thinned basally with incipient flutes (Haury 1953: Fig. 10). (See also Figs. 7, 8, 9A, 9B, and 10O).

Characteristics of Lake China Stone Industries

Most lithic inventories in the valley, as shown in histograms of Chapter 5, have in common the following characteristics:

1) They are flake industries (tools are modified flakes).

2) Flakes were reused, often showing two or three generations of reshaping scars. *These scars have very different degrees of weathering.* This is an indicator of stability of many of the landforms on which people camped as well as considerable age of the human occupancy.

3) Tools were progressively altered by resharpening: this is a corollary of the second characteristic, above.

4) *Parsimony*. Stone had to be packed in from far away and could not be wasted. People evidently shopped around when they made camp and scrounged what they could use.

In the great area surrounding Lake China basin there are numerous sources of good stone for artifacts: jasper and chalcedony from the Red Rock and Last Chance Canyon areas; agate from Sheep Springs; obsidian from the Cosos to the north; more jasper from Milspaugh and Bendire Canyons, also northward. However, all sources could only be reached by a long hike over rough country (see Fig. 22).

5) Combination tools (eg a spokeshave/convex scraper/beak composite) are common, like the ones shown in Fig. 23. All these are from a tiny site in the SW quarter

FIGURE 22. Sources of tool materials.

of Stake 8, Quadrant A. *This may have been a women's work area.* There were no points or crescents, but mainly composite tools, suitable for peeling, boring, incising, stripping.

6) Tool makers preferred good jasper, chalcedony and obsidian (of which they were connoisseurs).

7) Blades are rare.

8) True burins of chisel type are rare (these people probably used specialized broad beaks for such work).

9) Ovate bifaces are scarce—probably reduced to make other tools.

10) Many tools are small (part of the conservationist trend).

11) All artifacts have a generally unstyled or deceptively amorphous appearance with the exception of the following classes of objects.

EXCEPTIONS

Points, knife/points, crescents, crescentics, "slug" scrapers, "biscuit" scrapers: these are all exceptions to the generally unstyled appearance of China Lake artifacts. In contrast, such important implements as spokeshaves and spur beaks are made on any handy flake. Hence, only the work element is significant: the notch or concavity in the case of spokeshaves, or the little spur in the case of spur beaks.

There also appear to be two cultural entities whose artifacts do not conform to the characteristics outlined previously. They are:

1) A possible Core Tool Tradition, postulated to be very early.

2) Classic Clovis, which appears to be rather late.

These two separations are based, as before, on four criteria: a) weathering, b) morphology of the tools, c) technology and d) choice of material. As an experiment, weathering has been used as an important quality. Arrays of this nature in this report constitute testable hypotheses. Viewed in this manner, the Core Tool Tradition and Classic Clovis compare with the majority of the other assemblages like this:

Core Tool Tradition.—This toolkit has discrete characteristics of its own: more massive tools (choppers and chopping-tools); a few flake tools; very rough percussion flaking; a preference for volcanics and chert, but no obsidian; a limited toolkit of beaks, end scrapers, biscuit scrapers, spokeshaves, the choppers and possibly cordiform knife/points. *Extreme weathering* is noted on these tools.

Classic Clovis.—These implements show outstanding technological advances. It is a beautiful inventory: great varieties of flake and also core tools; refined, pressure flaking; selection of only the finest grade of stone, which is heat-treated. These people also appear to have made fluted knife/points, which are recognizably thicker and shorter than the very long and thin, basally fluted lanceolates of their predecessors. This inventory shows *slight sandblasting.* (See Figs. 11A, 11B, and 12).

STASIS OR DISPLACEMENT OF THE ARTIFACTS?

There are examples of artifacts that have remained unmoved for amazing periods of time, of artifacts that have been moved by water, and of artifacts that have been moved by the wind. All transport that we noted, however, was short—(long range removal being rare in this flat basin with a relief of 5 to 10 feet). The average gradient across our Test Area is 11 feet in a mile and a quarter.

1) *Stability.* Stake 1 (previously cited) is an example of stability over the past 10,000 to 11,000 years. It has already been cited as a locus where, by combining information from backhoe cuts and surface mapping, we were able to postulate the presence of artifacts buried under the gravel mantle. These were found on and in a paleosol now being exposed by erosion. However, erosion in this case implies exposure but little movement.

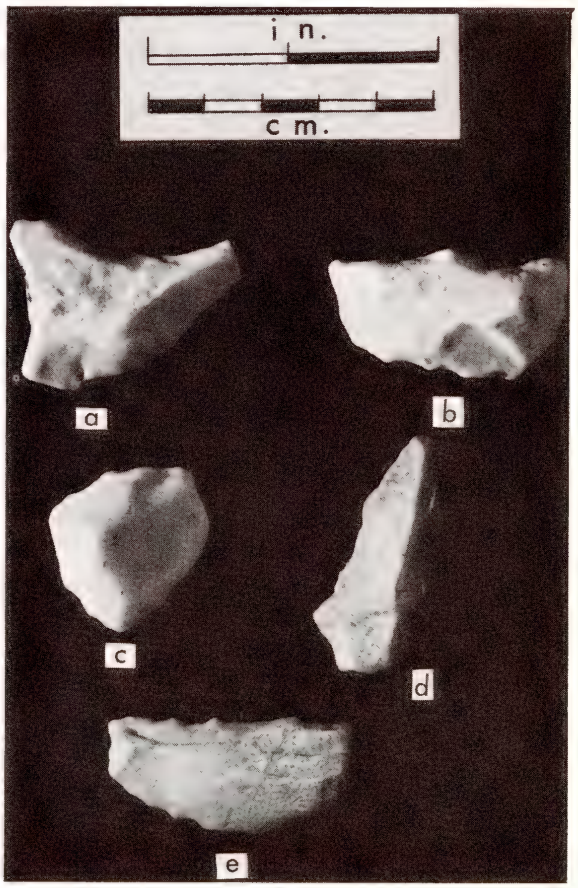


FIGURE 23. Composite flake tools from a tiny site which may have been a women's work area in the SW¼ of Stake 8A.

The artifacts and carbonate pods from the paleosol would not have retained their arcuate configuration had there been displacement of any magnitude (see Fig. 21).

2) *Artifacts moved by water.* We have observed this in two different situations: a) transport by rill action and b) migration into shallow hollows, which fill with water each time it rains heavily.

3) *Artifacts moved by wind.* The first site we found on Transect A was a small blowout, scoured down to the silt and surrounded by coarse sand. This blowout contained two populations of flakes: a) some worn-looking silicates, mostly chalcedony, on the north perimeter and b) less-sanded obsidian in the center. The chalcedony flakes were thick and did not appear to have been moved. The obsidian flakes represented a different technology, being very wide and thin. Many of them had, therefore, been picked up, carried downwind and dropped in various positions on the gravel slope.

4) *Wind competence tests.* Ground wind action in two localities (stakes 13 and 25 NW) was tested in the following manner: a) Six samples were prepared for each test site. The samples were chunks and flakes of steatite (soapstone), painted black and white, weighed in grams and marked with pencil. Weights ran from 0.5 to 8.3 g. b) These samples were placed against flagged nails, six at each site. The smallest specimen at 25 NW disappeared at once, possibly taken by an inquisitive raven. c) After 15 months, the following changes had taken place.

5) *Shifts.* Every piece had moved from 0.5 to 3 cm, *but in different directions.* One large piece with a steep face had moved furthest. None of the shifts seemed consistently related to the prevailing winds. A suggested explanation is that the marker bush, near which the specimens were located, produced a burble in the wind with willy-waugh gust effects. Water pouring off the bush during rains probably was also an effective agent. The conformation of the piece was part of the dynamic system. As an example, a steep side evidently offered more flat-plate resistance to both wind and water. Thin specimens that had become incorporated in the dense gravel moved the least.

Number of Specimens in the Total Collection.

Classifiable tools	> 5,347
Flakes	>15,754

Still untabulated are: a) Several hundred tools and flakes in bags which happened to have been overlooked when the collection was transferred. b) The Fagnant collection (now available to us), which was not at hand during the recent arraying and artifact counts. Eventual incorporation of these segments of information will appreciably raise the above numbers. This is a huge corpus of Western PaleoIndian materials.

FIRST ARRAY AND SCAN OF THE ARTIFACTS: OBJECTIVES

It must be clearly understood that this first sorting of the materials *is not a final analysis.* That would have been premature, since we did not really know what we were working with. The first sorting of artifacts was intuitive, introspective, painstaking—and took a long time (about four hours a day, seven days a week for four months). This preliminary scan gives us an overview; insights into new artifact types (such as crescentics vs. crescents, saws, broadbeaks of three designs and "steak knives," which are exquisitely fine-toothed little butchering tools); and a clearer idea of ways in which the collection can be analyzed in the future. That is:

Technologically
Statistically
Ecologically
Comparatively (within this site region)
Chronologically

A controlled collection of this size, and a record of mapped sites of the amplitude shown in Chapter 5, offer unique opportunities for computer studies. This work should be done by different individuals. The collection should be a source for a number of PhD dissertations and MA theses. Most artifacts are marked with a number, which identifies them with a place on the plane table maps, permitting great versatility in reconstructing the on-site relationships.

A comparable collection, precisely controlled, may not be made again in bulldozed North America. There are plenty of good archaeologists to do the work, but no virgin territory left unpothunted. Had it not been that all the sites cited in this study lie within highly restricted missile impact ranges of the Naval Weapons Center, the area would have been picked clean by "collectors" (thieves from the public realm) and this work could never have been done.

Methods of Arraying the Collection

All artifacts are packaged according to Quadrant (152.5 m square), each of which represented one-quarter of a standard stake—305 m square. Quadrants were labelled A, B, C, D or I, II, III, IV. (Refer to the site maps in Chapter 5.) For the array, every stake was worked through, quadrant by quadrant, starting with A or I as the case might be. As an example, contents of the A bags from a stake were spread on the table and slowly inspected, turning each piece to all angles and holding it obliquely to the sunlight. It was a rapt study in which we established a mystical bond with these worn fragments. We used to talk to them like an Eskimo carver holding a block of ivory and

searching for its *inua,* its spirit. "Who are you who dwells in there?" Through such absorbed, complete immersion, we began to see a host of new qualities so that the stone, a surrogate for a person, a Spirit, became a living entity in itself. In this way, we participated in an experience far transcending mere sterile detail—a deeply enjoyable experience.

The first step in the inspection was a separation of tools (including any flakes with sign of use or modification) from flakes and chunks which could not be "read." All these latter were lumped as flakes and were then sorted and counted according to material: silicate, obsidian, basalt and rhyolite (see the histograms, one for each site, in Chapter 5). Then the tools were sorted by class as shown in Table 5. Considerable experimentation was required to arrive at a classificatory system adjusted to fit all the sites on all the stakes. Table 5 is this classification. For general packaging it worked quite well as can be seen from an inspection of the histograms. As my insight grew, it became clear that important and newly recognized artifact classes had been omitted because *it took time and experience to recognize them.* These new classes are:

Cutters
Saws
Shredders
Crescentics (different from crescents)
Broadbeaks (three types)
"Steak knives"

Criteria for Classifying

Four kinds of qualities were used in evaluation. These are ranked below, according to their immediate usefulness and heuristic value in this study as follows:

1) Weathering—Extreme, Heavy, Moderate, Slight, None } Silicate base
2) Function (mechanical competence of the working elements). (See Table 6).
3) Qualitative (shape, technology, raw material).
4) Quantitative (length, width, thickness, weight).

When the artifacts from a quadrant had been sorted from the noncommittal flakes, they were resorted by the above criteria into groups conforming to the use-categories in Table 5, which was used as an edge strip on a series of ledger sheets. A count was then taken of each category and recorded on the sheet. These ledger pages are the base for the histograms of site inventories used in Chapter 5. (See Tables 7 and 8).

A Testable Hypothesis of Weathering and an Alternate.—Weathering, while not generally used in attempting chronological ordering, seems to work reasonably well at Lake China and gives fairly consistent results. By using it in an experimental way, it has been possible to construct a testable hypothesis about cultural sequences in this area, shown in Table 1 (Chapter 1) and in the more extensive Table 9 at the end of this chapter. There appears to be a geochronological base for the consistency of relative weathering of various

Table 5

Functional/Morphological tool classes used in this preliminary report: first array

Class, type
Burin
Chopping tool
Microblade core
Flake
silicate
obsidian
basalt rhyolite
Blade
Ovate biface cutter
keel–1
keel–2
shoulder–1
shoulder–2
Flake cutter
curved
keel–1
keel–2
shoulder–1
shoulder–2
Lanceolate square base
Lanceolate concave base
fluted–1
fluted–2
converging sides
ovate side
Scraper
"slug"
round end
biscuit
side
spokeshave
Chopper
Spur beak
single
double
multiple
Broad beak
long borer
curved
triangular
Flake core
Core plane
Crescent
P/G rock
Unid. Knife/point
long ovate
stub ovate
notched
stemmed
Sharpening flake
Bone

TABLE 6

Functional considerations for artifact classification

Template	General Tasks	Hunting	Industrial	
Pointed/sturdy Sharp/bladed	kill . . .	pierce cut both		
Blunt/medium	stun	knockout disable	missile tips for small game and birds	
Heavy/obtuse	chop/split		chop/split wood (chopper) dismember game (chopping-tool)	Industrial chopping
Abrasive	grind		smooth (hard material) shape (hard material) pulverize (foods and soft materials)	Industrial grinding
Pointed/scriber Squared/chisel	groove		scratch groove (medium substance) Chisel groove (hard substance)	Industrial grooving
Blunt/heavy	pound		break splinter smash crack	Industrial pounding
Toothed, medium	saw		wood, roots, ligament and tendon	Industrial sawing
Medium to steep edge	scrape/thin		thin hide (convex blade) thin wood (straight blade) peel wood (concave blade)	Industrial scraping
Toothed, long	shred		reduce fibrous plants	Industrial shredding
Keen, fine-toothed	slice		slice meat (toothed) slice wood (smooth)	Industrial slicing
Material	This is secondary. A worker's first consideration is the nature of the task (column 2, above). The second consideration is *what* tool materials, within one of two categories, is available? The two material categories are volcanic glass, which is keen but brittle, versus all other volcanics and silicate rocks, which have various physical attributes.			

TABLE 7

Components of PaleoIndian butchering toolkits (various phases).

Tool class		Use
Pounding/grinding rocks	Smashing Crushing Pulverizing ♀	bone roots and vegetal material pigments, nuts, dried meat
Choppers	Animal processing	butchering, disjointing, scraping
Chopping-tools	Plant processing	cutting, chopping
Cordiform knife/point Proto-Clovis long knives Clovis fluted knife/points Bifaces and performs	Animal processing	general cutting, skinning, carving, dismembering
Flake cutters	Animal processing Bird processing Plant processing	meat cutting, jerky slicing trimming feathers, meat slicing trimming, splitting
Classic Clovis "Steak knives"	Animal processing	cleaning small pelts slicing meat for jerky fine butchering (tongues, organs)

TABLE 8

Provenience and characteristics of Lake China Basin pounding and grinding rocks.

Evidence of use	Stake 19 SW	T 25S, R4oE Bone Site NO. 3	Stake 25	Mammoth NO. 1	Mammoth NO. 4	Stake 19, A	Stake 22, A	Stake 7	Stake 25 NW	Trans. A	Site 1	Stake 8
Pounding	6?	4										
Grinding (rough)												
Grinding (fine)		2										
Anvil		4					3		1	1		
Unid. frg.		1	7			19		1	5		1	
End Battered					3		1			1		
Core Tool		1							1			

Form	Material
Flat cobble, circular or ovoid	Quartzite
Spherical cobble	Scoreaceous basalt
Pyramidal cobble	Porphyritic basalt
Flat, irregular anvil slab	Porphyritic andesite
	Granitic rock (various)

artifacts, which is a corollary of the hypothesis. The setting, water supply and geochronology of Pleistocene Lake China all suggest an endless series of oscillations of this shallow body of water, implying repeated masking of the valley floor with lacustrine deposits and repeated, partial or total, denudation by water and wind erosion. This means that the longer an artifact has occupied the valley, the greater its statistical liability to repeated exposure to weathering: the abrasive action of sand-loaded wind and the caustic action of a highly alkaline environment. In addition, a few of the obsidian pieces look as though they had been water-rolled as rising water lapped around the surface on which they lay.

In order to test this hypothesis, the artifacts should be rearrayed according to entirely different criteria to observe the degree of "fit." We have experimented with weathering at this point because it has been a workable way to seriate a huge, composite collection from surfaces of a changing lake-desert environment over what may be a surprisingly long span of time.

The theoretical usefulness of weathering as an age index is that it allows us to construct a model of Mojave Desert prehistory and New World cultural progressions large enough, and with enough slack, to accommodate a very slow spread of human beings in the Americas and to explain occasional sites with dates earlier than 10,000 years BC. Guitarrero Cave in northern Peru (Lynch 1970) is a secure example of such a site. The Taber Site in Alberta (Stalker 1969:424) with an age estimated by the geologist as greater than 37,000 BC seems to be another.

The great physical diversity of American Indians (outside of repetitive blood groups, which may have been peculiar to most PaleoSiberian populations 40,000 years ago) is hard to explain as a result of a Clovis Conquest only 11,000 years ago. The astonishing linguistic diversity of American Indians is even harder to account for.

However, it is essential to be our own Devil's Advocates and to propose another hypothesis as an alternate to the model, which is adumbrated in Table 10. To this end, let us postulate that weathering is an unreliable criterion of age for the following general reason: there are too many variables involved in the process of physical/chemical alteration of rocks. These variables are:

1) Composition of the rock.
2) Climatic circumstances of exposure—wet? windy?
3) Length of exposure?

An age equation would have to be solved for each of these variables in turn. This would be difficult.

However, there is a more open-ended possibility that should be considered separately. The open-ended possibility for theory construction (and the more valid of the two) would be to use our field maps-collections correlations in exactly the manner for which they were devised; that is, to reconstruct the artifact distributions on a sample number of 305 m squares by the simple technique of putting the requisite plane table map on a sorting table, withdrawing the matching artifact bag from its Stake package and reconstructing the site to the greatest extent possible. It would not be perfect (e.g., many significant artifacts were not recognized as such in the field and were bagged as "flakes"). However, *in this manner we could come close to a horizontal stratigraphy,* a model based solidly on our field data. This idea has been conceptualized before (Rogers 1939), but our mapping program gives a better promise of reliability.

TABLE 9

Hypothesis one. Long count chronology: a tentative outline of Pleistocene Lake China prehistory as inferred from the stone tools. Criteria for this array in order of importance are 1) weathering, 2) technology, 3) function and 4) choice of material.

Cultural Association	Tool inventory	Stone technology	Weathering
A. *Early and Late Core Tool Traditions,* Asian cordiform and ovate weapons Est. 45,000 to 25,000 years BP	• Choppers • Chopping-tools • Large spokeshaves • Stubby, broad beaks • Long, ovate knife/points • Cordiform knife/points • Large flake tools • Bone tools and weapons? • Pounding/grinding rocks	• Rock smashing • Coarse, irregular percussion— • Chert and volcanic rock preferred— • No use of obsidian	• *Extreme*. Deep pitting and scouring of all flake scars—softer material or flaws removed by *devitrification*— • Many flake scars obliterated (Figs. 7–8)
(Note: there is a marked change in the artifacts at this point)			
B. *Late Wisconsin Cultures: I* Ovate weapons continue Est. 25,000 to 20,000 years BP	• Fewer, smaller choppers and chopping-tools • Spokeshaves more varied in size • Broad beaks diversify into long-borer and triangular forms— • End scrapers • Crescents • Crescentic scrapers • Long ovate knife/points • Ovoid "biscuit" scrapers • Valsequillo knife/points (small cordiforms) • Pounding/grinding rocks • Bone tools and weapons?	• Smaller, more refined tools • Irregular, percussion • Jasper and volcanic rock preferred, rhyolite in evidence • No obsidian	• *Heavy* erosion, due as much to chemical as to physical weathering— • Flake scars sanded and pitted (Fig. 9)
C. *Late Wisconsin Cultures: II* Ovate weapons continued Est. 20,000 to 15,000 years BP	• Tool classes as above with additions: • Composite small tools • Obsidian introduced • Crescents become diversified • Spur beaks (gravers) • Slug scrapers • Many broad beak styles • Side-knives (scrapers) more specialized • "Cutters" become more numerous • Bone points and tools?	• Irregular percussion flaking • Refinement and smaller size • Pressure retouch • Stemmed-ovate forms appear • Lake Mojave and San Dieguito knife/points established	• *Heavy* to *moderate* weathering • Flake scars clearer except on obsidian (Fig. 9)
D. *Proto-Clovis Cultures* New, lanceolate knives added to ovate forms Est. 15,000 to 13,000 years BP	• A few blades • Microflake cores? • Long, lanceolate knife/points of Sandia pattern • Crescents more varied • Crescentics more varied • Spur and broad beaks more specialized • Stemmed tools with *two* shoulders appear • Stemmed knife/points with flutes • Mini- and micro-spokeshaves (for baskets?) • Saws • Shredders	• Increased cultural interaction, loans and innovations • Greatly extended use of flake tools • *New technology used: use of punch or hard wood flaker to remove wide, thin spalls* • *A second technological innovation appears: basal flutes* • Heat treatment of silicate stone	• Sand blasting and chemical alteration, but flake scars clearer than previously (Fig. 10)

TABLE 9 (continued)

Hypothesis one. Long count chronology: a tentative outline of Pleistocene Lake China prehistory as inferred from the stone tools. Criteria for this array in order of importance are 1) weathering, 2) technology, 3) function and 4) choice of material.

Cultural Association	Tool inventory	Stone technology	Weathering
	• "Steak knives" • Pounding/grinding rocks facetted		
E. *Classic Clovis Phase* Lanceolate tools proliferate Est. 13,000 to 10,800 years BP	• (All above tools plus general refinements) • Women's work tools • Refined steak knives • Micro-tools common • Fluted knife/points diversify • End scrapers tanged • Pounding/grinding rocks more specialized • Bone tools? • Micro-shredders and spokeshaves	• Stone technology reaches a peak of sophistication: signatures are • a) choicest stone • b) heat treatment • c) exquisite workmanship • Fine obsidian popular	• *Moderate to light* sand blasting • Flake scars clear (Figs. 11 and 12)
F. *Pinto Phase* Est. 5,000 years to 3,000 BP	• Serrated and notched weapons appear • Basic, PaleoIndian toolkit continues except for hunting/ butchering gear	• Obsidian predominant • Flake scars narrower and less refined • Heat treatment disappears	• *Light* sand blasting
G. *Cultural gap?* (Arid climate returns) 2,500 years BP	• Elko, Cottonwood and Rose Spring points • Milling • Basketry	• "Desert Culture" technologies	• Obsidian bright and unsanded
H. *Proto-Historic Shoshoni* 2,000 BP to present time	• Desert side-notched • Rose Spring • Cottonwood points • Basketry • Milling • Pottery after AD 1,700	• Desert Culture adaptations vary with climatic cycles	• No visible weathering

This interesting and valuable work must await our second levels of analysis, and could not be undertaken during the present tactic of scanning and appraisal. A Site Reconstruction Tactic is open because it is loaded with possibilities of novelty and surprise. Scientific thought is not confined to mathematics and exact description: if a scientist cannot have the fun and game of problem solving through insight and discovery, he might as well be a checker in the foodmarket.

Option 2 is a model of sudden human transgression into a New World. It is a theory, developed by Haynes (1964) and Martin (1973), proposing a sudden breakthrough of northern mammoth hunters as a corridor opened between the Laurentide and Cordilleran glaciers about 12,000 years BP. Clovis spearmen advanced along a widening front at the rate of 100 miles a year, and bursting upon an unsophisticated megafauna, decimating proboscideans, camels and horses, sweeping two continents and arriving at the tip of South America within 1,000 years. This theory implies that all human events, all cultural episodes in the New World, are subsequent to the Clovis invasion and have ancient roots in a Clovis substratum. Applied to the observable artifacts from Lake China basin, this Clovis Conquest—together with other dates and estimates on the age of supposedly later cultures—negates the model shown in Table 10.

Artifact Analysis Cards.—Five by eight edge-punched cards have been used in two ways in these studies: 1) in the field as a record of each artifact at the moment it was found (Davis 1975:39) and 2) a second smaller set has been compiled as part of the array and review of collections. There are 412 of these latter analysis cards, carefully drawn up in ink (the field cards are in pencil).

All of the 5,347 artifacts could be classified, but most are rather noncommittal members of their class. A few, however, are good talking examples; they have something to say to us and can be clearly explained to a newcomer. Four hundred and twelve of these good

TABLE 10

Archeolithic Sites and Dates of Pre-Clovis Cultures.

Site	Associated	Tools	Dates	^{14}C	Rac.	References
China Lake, Stake 22 Stake 25	Camel, Horse Mammoth	Archaeolithic Core-&-Flake Traditions; cordiform knife/points	Pending. Tools more extremely weathered than any others	—	—	Fig. 28, f & h this vol.
Del Mar	Human skull	—	Aspartic acid age: 48,000 years BP		0.53 •	Bada, J. L.; R. A. Schroeder & George F. Carter 1974a
Fell's Cave	Ext. fauna	Stone tools and points	11,000 ± 170 ^{14}C yrs. (I-3988)	•		Bryan, Alan. 1973: 244
Laguna Beach	Human skull & long bones	—	17,150 ± 1470 ^{14}C yrs. (UCLA-1233A)	•	0.25 •	Bada, J. L.; R. A. Schroeder & George F. Carter 1974a
Los Angeles Man	Skull frag.	—	>23,600 ^{14}C yrs. (UCLA 1430) 26,000 (Aspartic Ac.)	•	0.35 •	Bada, J. L.; R. A. Schroeder & George F. Carter 1974a
Meadowcroft Shelter	Basin-hearth	Stone artifacts	14,225 ± 975 BC (Smithsonian Inst.)	•		Adovasio, J. M. et al. 1975
Old Crow R. Alaska/Canada	Worked bone, caribou, mammoth, horse	Bone flesher etc.	25,750 ± 800 ^{14}C yrs. (GX1568) 29,100 ± 3000 ^{14}C yrs. (GX1567)	•		Irving W. N. & C. Harington 1973 Harington, C.; R. Bonnichsen & R. Morlan 1975
Iny-21 Panamint Val.	—	Archaeolithic Core-&-Flake Traditions; cordiform, pick, beak, chopper	None. Basalt weathered extremely compared to L. Mojave & Clovis artifacts	—	—	Davis, E. L.; Brott & Weide 1969 Fig. 15d etc. (Also, see Fig. 28g, f, h this volume)
Pikimachay, Peru	—	Archaeolithic Core Tool Tradit.	19,600 ± 3000 ^{14}C yrs. (UCLA 1953A)	•		MacNeish, R. S. 1970
Tagua-Tagua Chile	Horse, mastodon, charc'l	Stone tools	11,380 ± 320 ^{14}C yrs. (GX1205)	•		Montané, Julio 1968
Taima-Taima Venezuela	Mastodon bone & stone point	Flakes and an El Jobo point	14,010 ± 140 BP (IVIV-672)	•		Tamers, M. A. 1971
Timlin Site New York	—	Archaeolithic Core-&-Flake Tool Traditions with cordiform points	Possibly associated w. a 70,000 year old soil	•		Timlin, J. P. & B. E. Raemsch 1971
Tula River, Mexico	—	Archaeolithic (?) Core-&-Flake Tool Traditions with cordiform points	Unknown. Tools resemble Timlin, Lake China & Panamint Valley tools	—		Aldrich, Steven & J. Binder 1972
Valsequillo Mexico	Extinct animals	Obsidian Tools resembling those of Lake China	21,850 ± 850 ^{14}C yrs. (W-1895)	•		Irwin-Williams, C. 1967; 1968

examples have been carefully illustrated on 5 × 8 cards. Each card has an illustration of at least two views of the object. The card also gives provenience; length, width and thickness; material; flaking technology; additional refinements such as heat treatment of the raw material; and various observations such as degree of weathering, etc.

Photographs of these cards will be used as illustrations of the artifact descriptions, which are very brief. A three-dimensional object cannot be described in prose but only with an analog.

Microstudies.—Two days were spent inspecting artifacts under a binocular, dissecting microscope, with little success. Stone from the Test Area has been sanded

so completely that no traces of wear remain. Only the Henry Site (a small processing site with obsidian flake tools, horse and camel bone and one stemmed knife/point), had a few artifacts with irregular scratches on the dorsal surfaces. *This site should be restudied.*

DESCRIPTIONS AND DISCUSSION OF THE ARTIFACTS

The number of "type" tools that have been analyzed and illustrated on edge-punched cards are as follows:

Burins	4
Chopping-tools	5
Blades	2
Cutters	58
Knife/points	159
Scrapers, "biscuit"	4
Scrapers, round end	16
Scrapers, side	4
Scrapers, "slug"	12
Scrapers, spokeshave	17
Choppers	9
Spur beaks	22
Broad beaks	24
Cores	5
Crescents	41
Crescentics (not listed)	12
Ovate bifaces	8
Saws, shredders, "steak knives" (not listed)	7
Sharpening flake	1
TOTAL	410

The "unlisted" objects are those which were recognized belatedly, after the list and ledger sheets for making up the histograms (Chapter 5) already had been established.

1) Burins

Classic Burins.—This is a grooving or incising tool, comparable to our turning chisels. The working member—a chisel edge—is created by clipping a short, straight spall from a thick flake; the resultant flake-edge chisel is both sharp and sturdy. Tuohy (1969:132) has identified a burin technology of this type as part of a Paleo-Desert tradition group within the Western Lithic Co-tradition (Davis 1969:28). The technology appears early, in Nevada, with a practice of removing burin spalls from broken points. At Lake China, however, classic burins are rare (Fig. 24d-g).

Ski-tip Burin.—A few spur beaks are thick and wide and are turned upward like the tip of a ski. Experiment shows that this form, if tightly gripped in the fist and drawn toward the worker, will score a deep groove in hard wood (or in bone which has been softened by boiling). They could, therefore, serve as burins (Fig. 24c).

2) Chopping-Tools

Originally defined by Movius (1949) as units within lower Paleolithic assemblages in Southeast Asia, chopping-tools are choppers with bifacial flaking. In the Lake China collections, chopping-tools are bifacial, massive implements, shaped on both sides with obtuse edges (45° or greater). They, therefore, are suitable for rough, heavy-duty work such as chopping and splitting (Fig. 24a-b).

3) Microflake Cores

There are a few of these small cores in the collection, although they are not common: as an example, Stake 7 produced one; many other stakes have none; whereas the Transect B, Site 3 locus produced 4. Extrapolating from Site 3, it is possible that microblade cores are late in time, because Site 3 is a playa-side work site, which could only have been used after Lake China had retreated almost to its present size and position. Two microflake cores are shown in Fig. 28a and b.

4) Flakes

Flakes in this collection are predominantly amorphous. A few are sidestruck (long axis approximately parallel to the striking platform). Blades are proportionately rare. Most flakes are irregular, are 3 cm or slightly more in length and, therefore, are probably large trimming flakes. It is interesting that very small finishing flakes (less than 1 cm long) are scarce, probably because they can be carried by the wind; however, the buried flakelets that we found in the paleosol under Stake 1 gravels are all trimming flakes, which lay on the surface for long enough to become appreciably sandblasted before the lake rose over them and covered them with gravel, sand and clay.

5) Ovate Biface Cutters

Some of the most widely distributed and numerous tools in these collections are various forms of small scalpels, called "cutters" in this report. Most of these little trimming and slicing tools are reshaped flakes, but a few are bifacial—ovate, lunate or stemmed in form (see Fig. 25b-e; also Fig. 27). The more carefully fabricated of these biface cutters intergrade with "Lake Mojave" pattern knife/points and bunts as

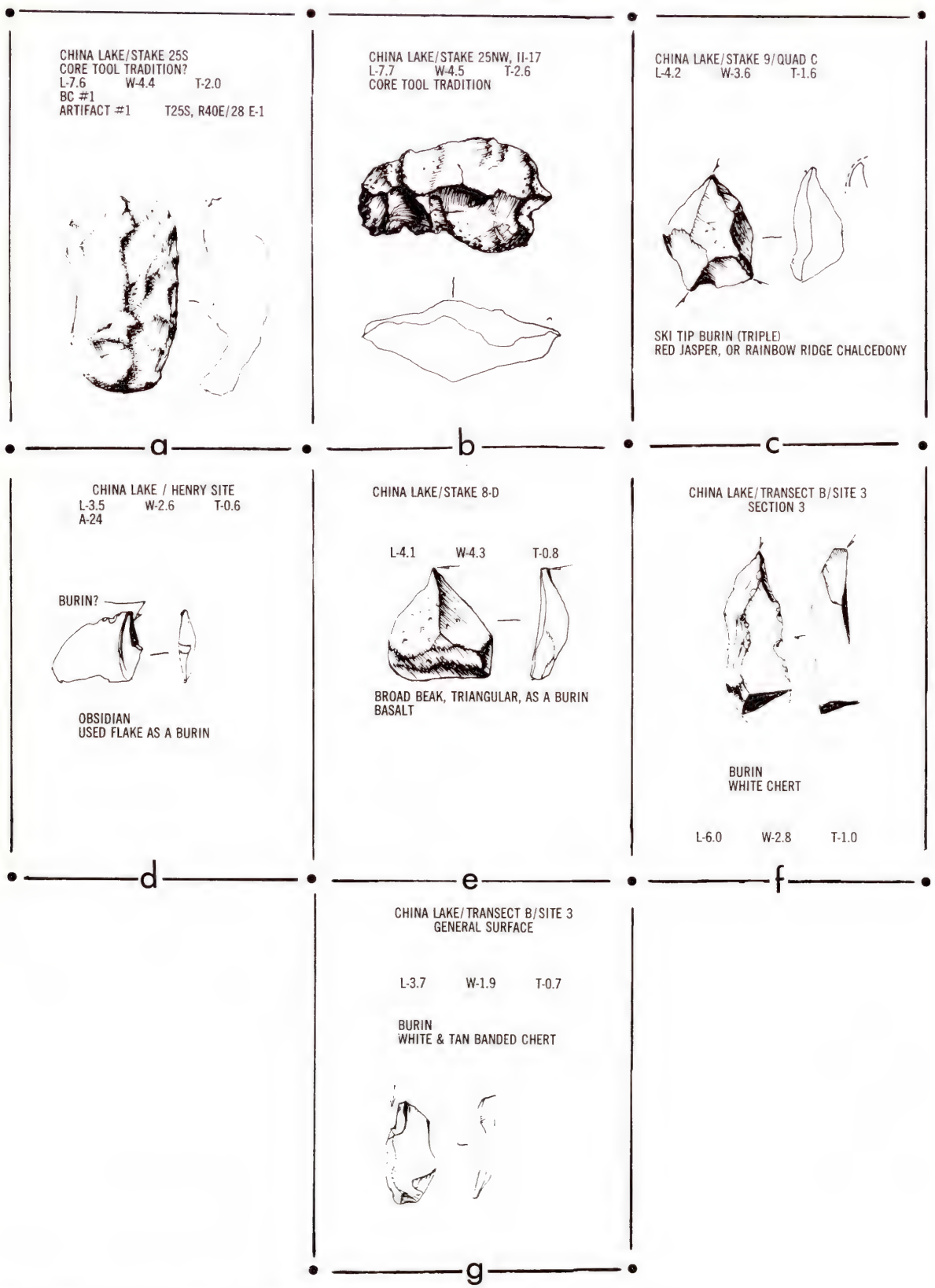


FIGURE 24. a-b) Core Tool Tradition Choppers; c) ski-tip burin; d) classic, European style burin; e-f) burins, chisel edge on a triangular, broad beak; g) European style burin.

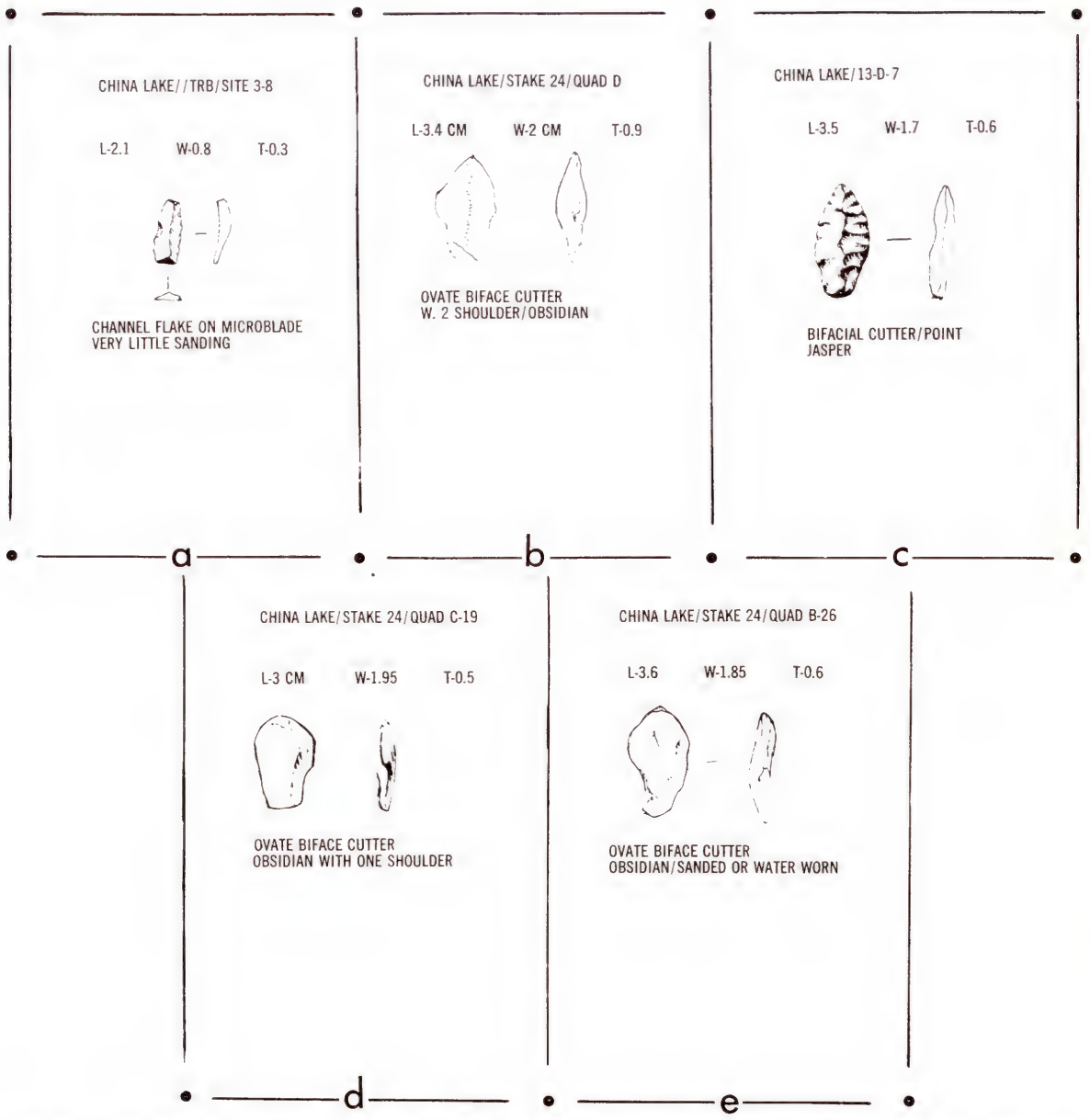


FIGURE 25. Blades and ovate bifacial cutters: a) microblade; b) bifacial cutter (very irregular); c) bifacial knife/point of Lake Mojave type, shown for purposes of contrast; d-e) ovate bifacial cutters.

shown in figure 27 and also in figures 9B, f-h. Fig. 9B, f is an excellent example. It has two shoulders and a stem like a "Lake Mojave Point" but could not possibly have been a projectile tip because it is curved in the sagittal plane—a "point" for shooting around corners.

6) Flake Cutters

These little tools are ubiquitous throughout the sites. They are specialized instruments, which are deceptively unspecialized in appearance: not one was recognized in the field but only after a long period of soaking in the collections on the part of the scanner. Flake cutters are sharp little flakes of various materials, frequently with a casual stem flaked on one end, suggesting that they were hafted on a stick. However, some of them—like the specimen shown in Fig. 26a—could only have been finger held. Many of the examples in Fig. 26 are from the remote Henry Site (see Chapter 5), where they constituted by far the most numerous tool class. The Henry Site evidently was a processing camp where at least portions of a horse and a camel were butchered. The large number of cutters in this toolkit

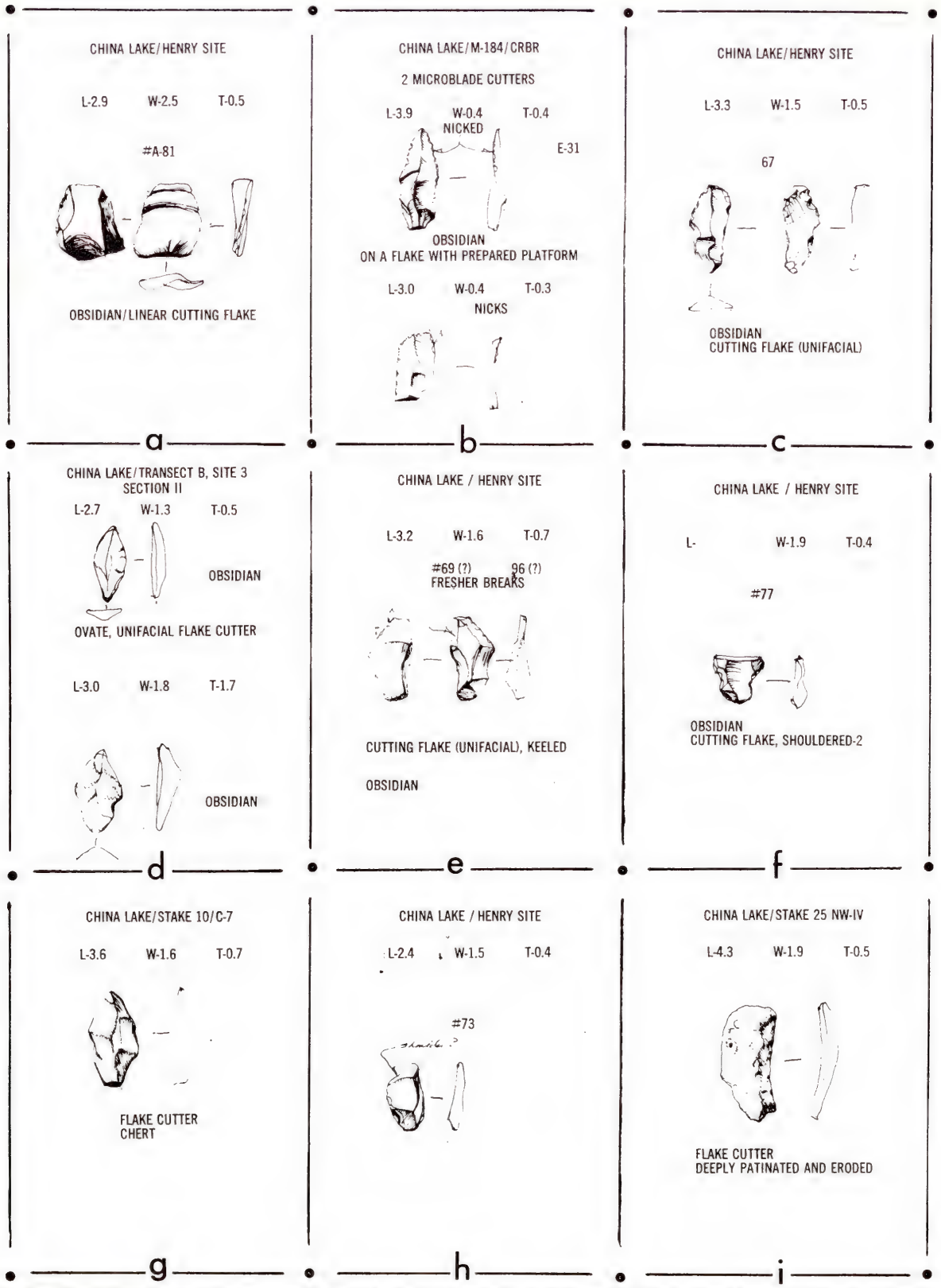


FIGURE 26. a-i) flake cutters: a) amorphous flake; b) keeled-1; c) keeled-1, shouldered-1; d) lunate form keeled-1; e) keeled-1 shouldered-2; f) shouldered-2; g) keeled-2, shouldered; h) lunate form, keeled-1, faint shoulder; i) keeled-1, shouldered-1. Heavily weathered—Lake Core Tool Tradition?

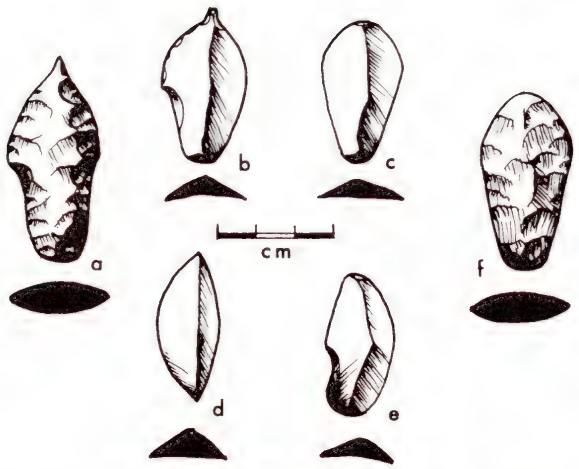


FIGURE 27. Lake Mojave points, bunts and cutters; a) bifacial knife/point weapon; b) flake cutter, spurred, keeled and shouldered-1; c) flake cutter, round end, keeled, no shoulders; d) flake cutter, semi-lunate, keeled-1; e) flake cutter, curved, keeled, shouldered-1; f) bifacial knife/bunt.

suggests that the people were slicing meat for jerky. Obsidian at this site is only slightly weathered, so that nicks and a few scratches—in various directions—can be seen on the cutters.

A practice of using flake cutters may be ancient in the valley, judging by the specimen from Stake 25 NW-IV, shown in Fig. 26i.

7) Steak Knives

These are a late refinement of the cutter model. They are almost as finely and regularly toothed as a hacksaw blade and appear to be a diagnostic of the Classic Clovis phase (Figs. 12b, e; and 51b, c). They were numerous at Basalt Ridge at shoreline levels, which evidently were processing areas.

8) Lanceolate Knife/Points: Square Base

This may not be a valid class of artifacts, but it has been left on the list and is illustrated in Fig. 28c-e. Fig. 28c may be a discarded blank; Fig. 28d and e were either knives or were preforms usable as knives (Judge 1973: 168). They are earmarked as Classic Clovis by the following characteristics: a) heat-treated stone; b) shallow, regular and rather wide flake scars; c) moderate to slight weathering.

9) Cordiform Knife/Points (not listed)

These heart-shaped objects were not listed as "cordiforms" in the histograms shown in Chapter 5, but were lumped with several other types into the group, "stub ovates" to conserve space on our highly compressed list of artifact classes and types (Table 5).

Cordiforms are rare, but might be very important. It is possible that they are the most ancient weapon type in this particular area of the western Lakes Country (Fig. 14 in Chapter 2), judging by an extremely weathered specimen from Site Iny-21 in neighboring Panamint Valley (Fig. 28g). Two other specimens of this heart-shape are shown in Fig. 28f and h. One of these (28h) is only half as large as the neighbor specimen from Panamint, but also is weathered heavily. Fig. 28f also was eroded greatly and pitted by weather, but this feature is disguised partly by much more recent flaking along the top and sides.

If cordiforms are, in time, found to be an older weapon design (possibly derived from Siberian Mousterian antecedents) than the long ovate bipoints, then Fig. 32 will have to be revised to place cordiform knife/points at a central position at the cultural base of Lakes Country sequences.

Siberian cordiforms are discussed again at the end of this chapter, together with Jelinek's illustrated report of one of these rare objects (1966:434). This specimen is thick in cross section and has been roughly shaped with percussion blows, which produced step-flaking. It apparently derived from the same stratigraphic unit as a Pleistocene vertebrate fauna. The unit was characterized by patches of deep red, cemented sand, traces of which still adhered to the artifact.

It is interesting that a small (possibly late) cordiform variant occurs both in the basin of Lake China and at the Hueyatlaco PaleoIndian site in Mexico (Irwin-Williams 1967:337 and plate 1-7).

10) Lanceolate Knife/Points, Concave Base

A Proposed Clovis Sequence.—The mid-point of this description of artifacts is a good place for discussion of a proposed Clovis sequence, from long knives (Proto-Clovis) to a Classic Clovis phase. Like other time/culture continua proposed in this study, a Clovis sequence is entirely conjectural—a testable hypothesis. It is at present unsubstantiated by excavation or by proven stratigraphic relationships. We must search for these.

Therefore, a Proto-Clovis to Clovis progression is postulated on criteria already discussed: weathering, technology, quantitative and qualitative factors and morphology. There also is a spatial separation, attributable to a valid *horizontal* stratigraphy. Proto-Clovis is proportionately more frequent around the Stake 25, 25NW and 19SW area (which we intuit to be our oldest group of loci) whereas Classic Clovis is proportionally more frequent around the Basalt Ridge, further north

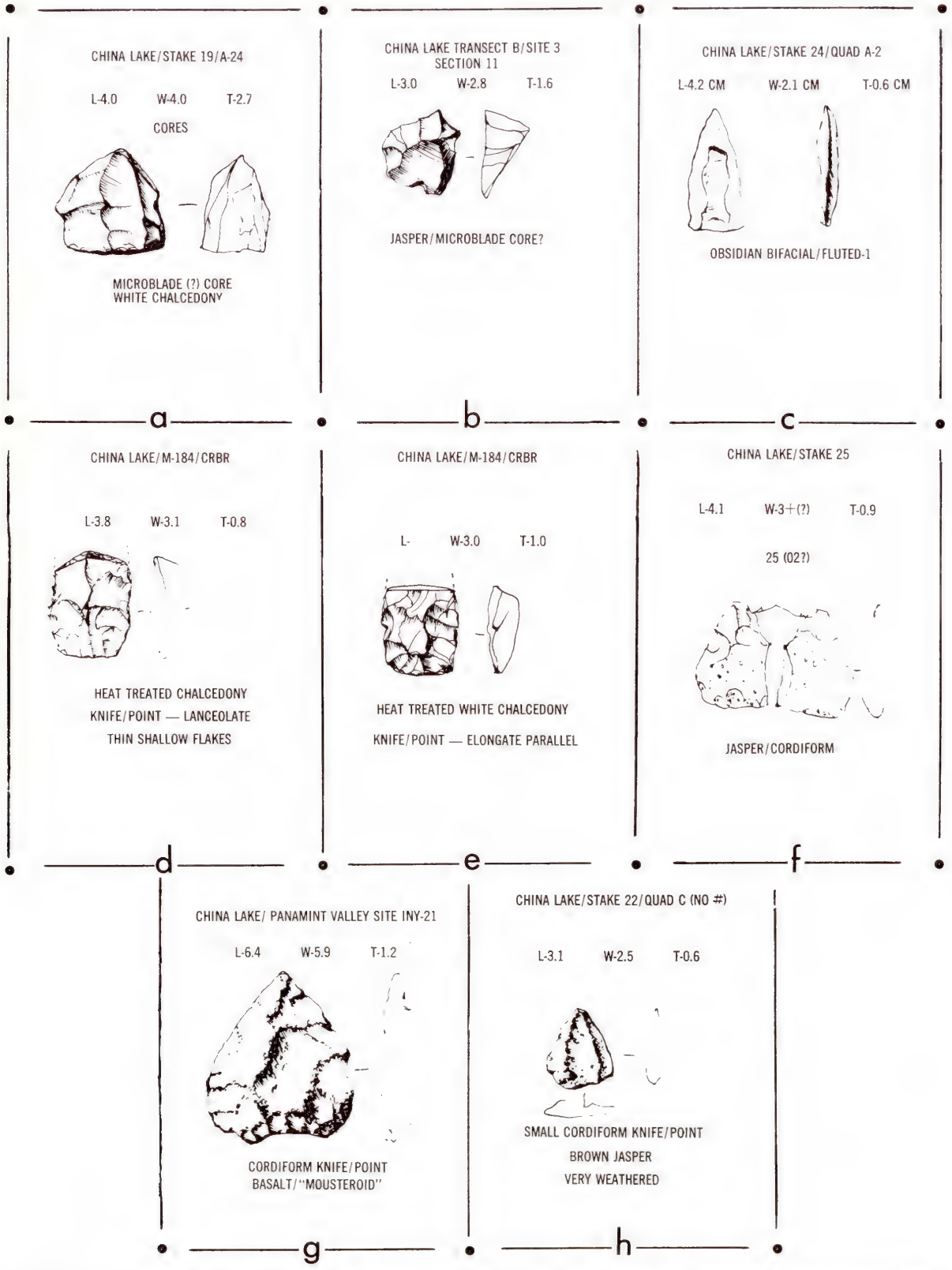


FIGURE 28. a-b) microflake cores; c) square base lanceolate, fluted 1 side; d-e) square base, lanceolate knives or knife/points, Classic Clovis; f-h) cordiform knife/points, Lake China (f,h) and Lake Panamint (g).

and in a different relationship to a higher stand of Lake China, which would have flooded Stake 25.

Various forms of the proposed Fluting Co-tradition knife/point series are shown in Fig. 10 and Figs. 29-32, as follows.

1) *Proto-Clovis*. (Figs. 10 and 29). To appreciate the importance of this hypothetical sequence, it is necessary to understand that, to date, Clovis (as known east of the Continental Divide) is a culture and a technology without roots. It suddenly appears, having sprung, full blown, from nowhere.

WE PROPOSE THAT ITS ROOTS ARE IN THE LAKES COUNTRY. Further discussion will be presented at the end of this chapter.

Long, lanceolate knives may be the bridge between Clovis and the past. Most of the long, single-shouldered knives are weathered heavily as shown in Fig. 10c, e, f (also see Fig. 29b-c, e-f and g). The objects in Fig. 29h and i may be unfinished blanks, although the way they have been snapped suggests that they were broken while being used as knives on a tough butchering assignment.

Another knife/point design (postulated to be later in time) is shown in Fig. 30a-e and g; these are all lanceolates. A much more ovate silhouette is seen in Fig. 30f, h and i. These ovates with ears and flutes are common in California and may represent a melding of two traditions of weapon manufacture and use: the Western Lithic Co-tradition characterized first by long ovates with stems; and the newer long knives, proposed as a base for the Fluting Co-tradition. At this point in time (a state within a poorly understood time trajectory), those stemmed artifacts that are best known as Lake Mojave points, may have evolved as a different expression of the same general kinds of cultural blending and technological change. Our sample indicates that late Lake Mojave and Classic Clovis are companions.

2) *Transition*. Trends toward Classic Clovis may be discernible in Fig. 29a and f and Fig. 30a. Unfortunately, all the specimens have been snapped off too short for any trace of a shoulder to be visible (if a shoulder existed). Fig. 30f has been shattered by impact. All the other specimens in this illustration that have been broken appear to have been broken by torque associated with use as knives.

3) *Classic Clovis*. Fig. 30a-i illustrate a morphological seriation of a group of knife/points from a), the proximal end of a long knife to i), which may be a late or terminal form in far western variants of a Clovis progression. Fig. 31 illustrates a continuation of Mojave Desert Clovis forms, grading into still other variants. There is a trend toward "fish tails" or "ears" (Fig. 31c-e) and a new shape with a needle sharp distal end appears (Fig. 31f). These needle-pointed lanceolates are found in a processing camp—the Rock Pile Site—on the west shore of Basalt Ridge, where they are associated with many other tools and flakes and tooth enamel fragments of mammoth, camel and possibly horse. They truly are piercing instruments and may well have been used in killing the animals represented by the tooth detritus. The needle-points are true points, whereas Proto-Clovis long knives and Classic Clovis knife/points are designed for cutting.

Two broken-off distal ends of long knives were mapped on Stake 27, a test square within an area that was a butchering and hunting territory controlled by camps at Stake 25 (Chapter 5).

This same knife/point design bears a resemblance to the Ichuña/Arcata point from Guitarrero Cave in northern Peru, with associated dates from Level II of 8,585 and 8,525 BC (Lynch 1970:1307). The lowest level in this cave had a date, associated with a human mandible, or more than 10,000 years BC. The Ichuña/Arcata type is only one of a number of close correspondences we have noted between Lake China tools and those from PaleoIndian sites in South America and Mexico: Ayacucho, Guitarrero and Hueyatlaco (Valsequillo). It is as though there had been a slow, steady cultural flow through the Americas during late Wisconsin millennia: through the Intermontane west of North America, then trickling past the bottlenecks of Mexico and Panama into the Andean and coastal corridors of South America (Ossa 1972).

One of the theoretical postulates of this report, therefore, is a probability that by the time the Fluting Co-tradition appeared in the Great Basin (with the introduction of basally fluted long knives) there already was cultural, genetic and linguistic diversity in the vast Intermontane Lakes Country.

The morphology of western Clovis materials has been presented; this included such quantitative characteristics as dimensions of each specimen as shown on the cards. Additional qualitative criteria used in the array are weathering (pros and cons of which will be discussed later) and technology.

4) *Classic Clovis qualitative attributes*.

Weathering: slight to moderate sand blasting.

Technology: Indicates great refinement. High quality silicate stone was selected and improved by heat treatment. Both bifacial tools (see Fig. 11A, showing a crescent and a knife or preform fragment) and unifacial as well as flake tools were made with superb workmanship, as shown in Figs. 11B and 12. Fig. 11A, an enlargement of a closeup photograph, illustrates the knapping technique well. In this respect, the technology basically is similar to that used in making the Proto-Clovis long knives—very wide, shallow, regularized flake removals, probably by a hardwood flaker combined with pressure finish of working edges. In

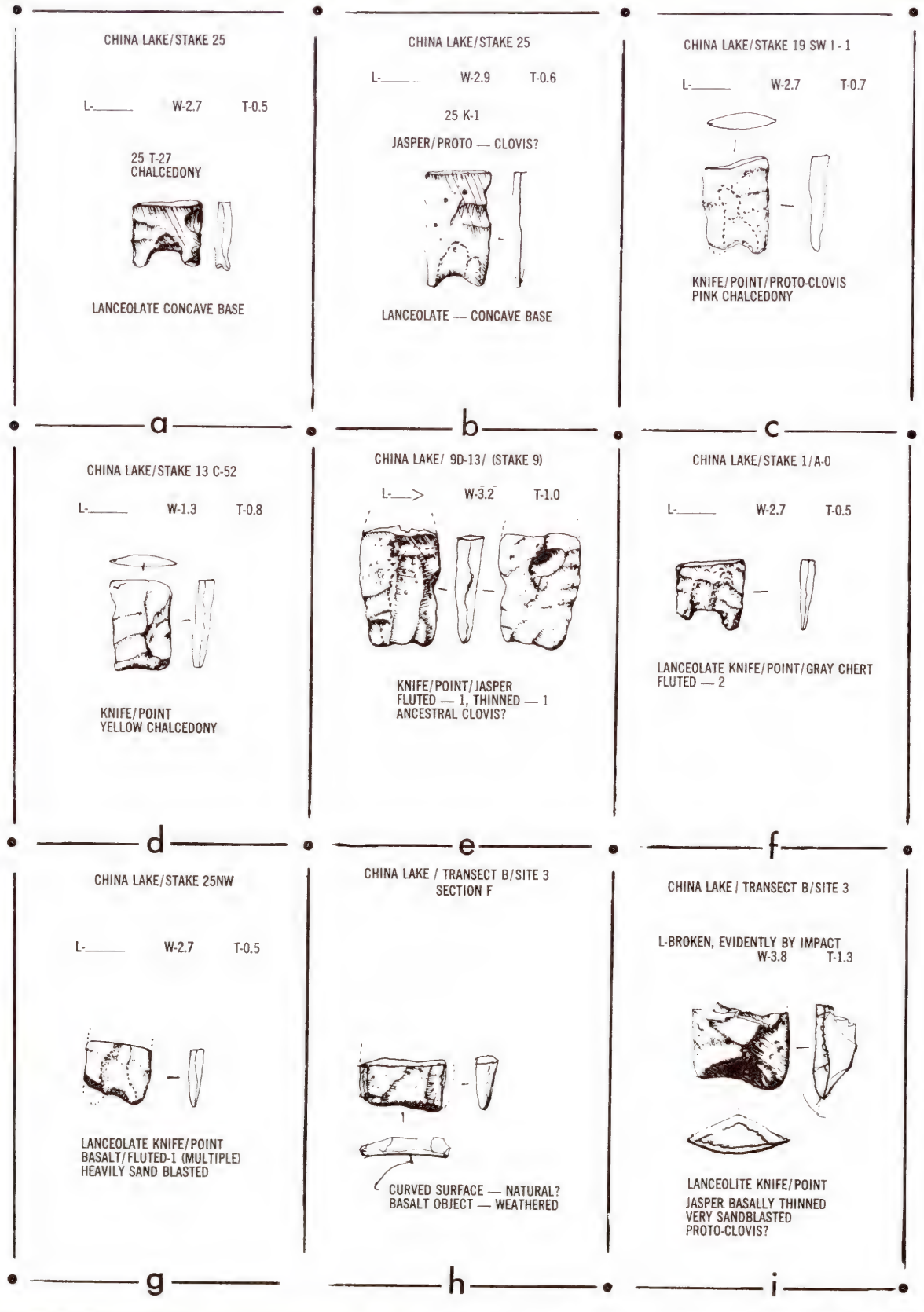


FIGURE 29. Proto-Clovis(?) and transitional, proximal fragments of knife/points. a) naturally thin specimen—transitional?; b-g) possibly transitional to Classic Clovis; h-i) Proto-Clovis blanks?

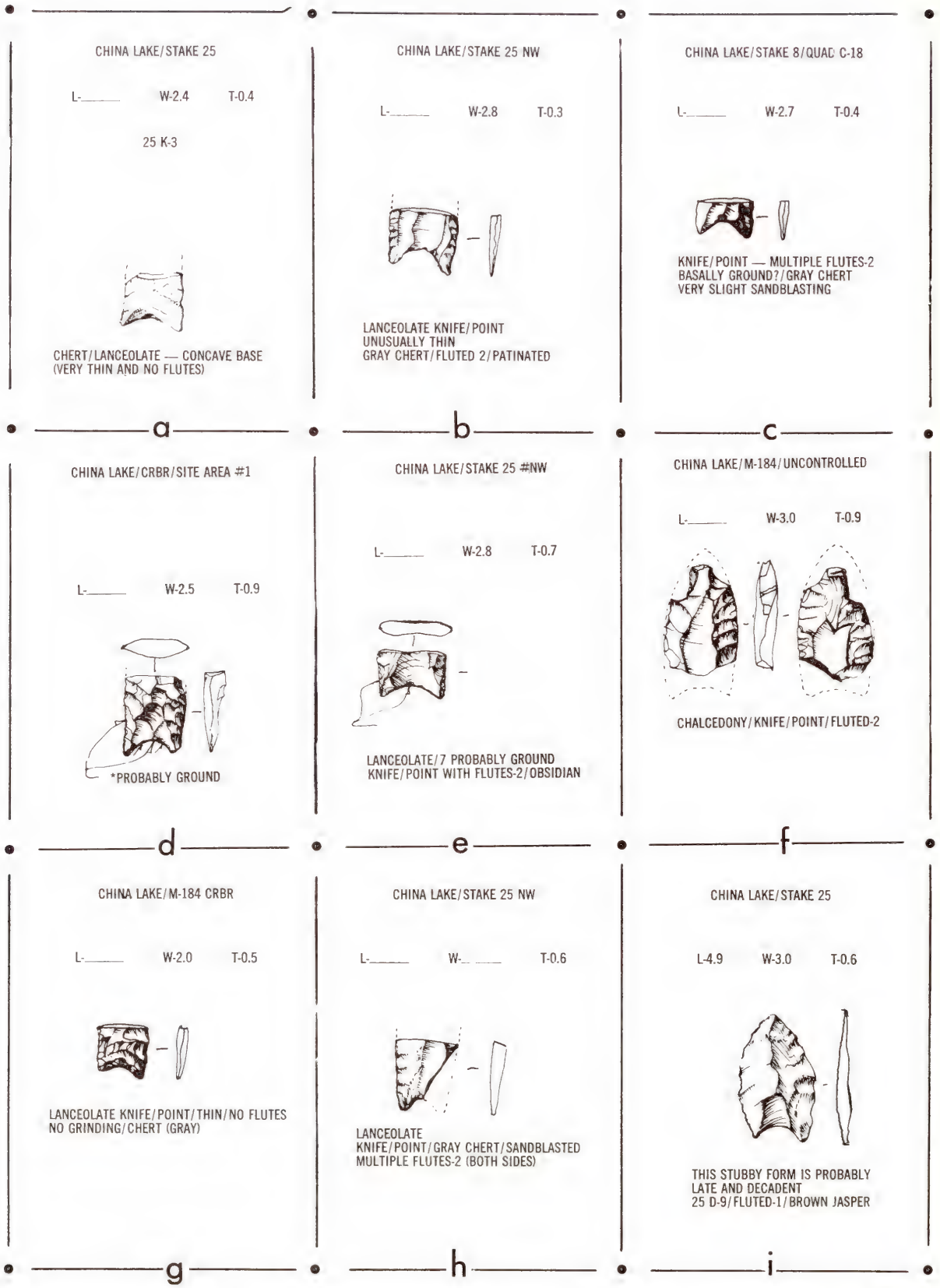


FIGURE 30. a-c) lanceolate knife/points various sites; d-f) Classic Clovis from Basalt Ridge locality; g-i) three designs of Western Clovis.

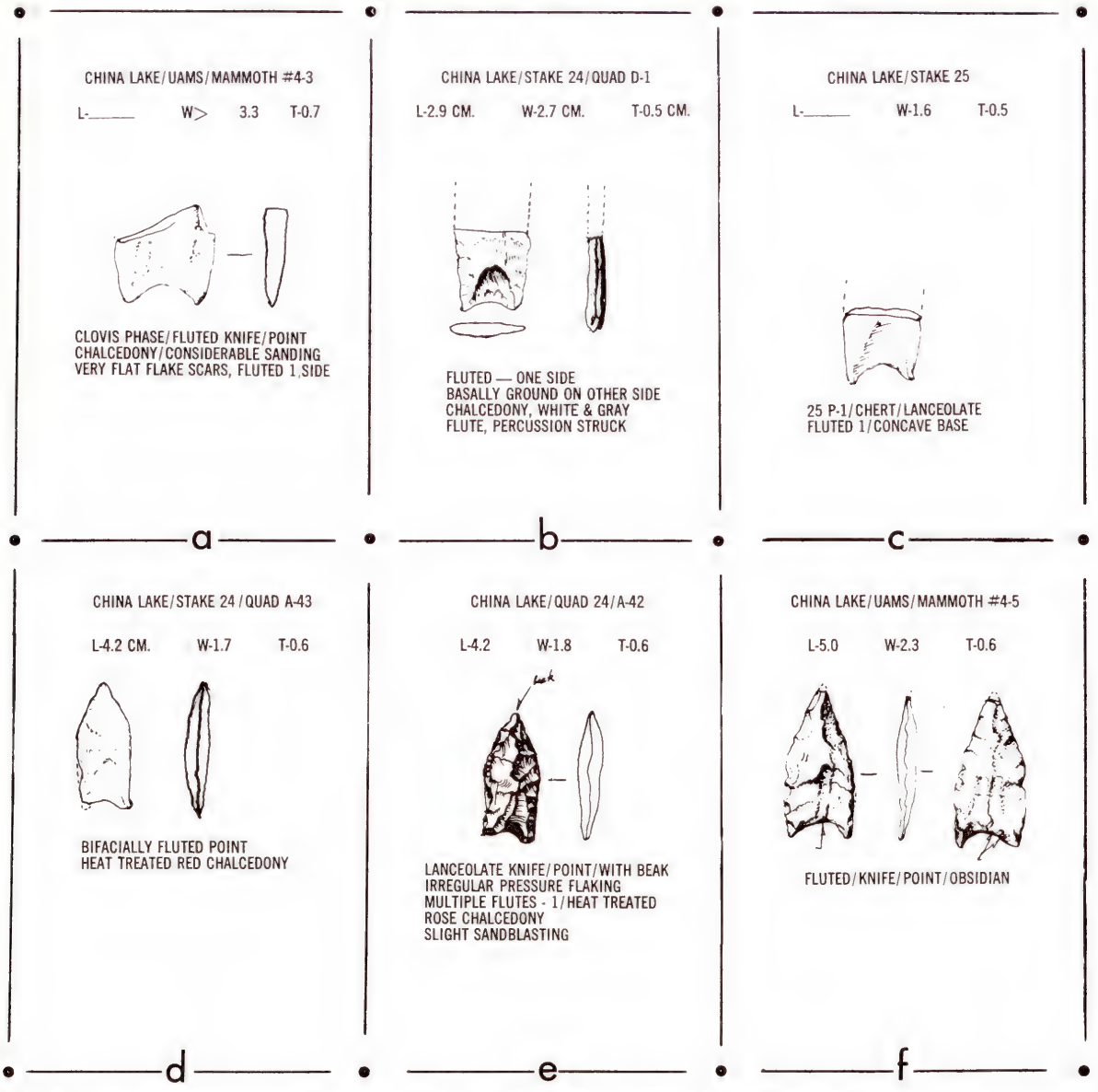


FIGURE 31. a-c) three more designs of Western Clovis; d-f) sharp nosed variants of Clovis. These are probably *killing* points while the variants, broader and blunter models, were better for butchering.

summary, the shaping techniques have a symmetry and precision not found previously in Mojave Desert toolkits.

The crescent shown in Fig. 11A, top, is a good example. It is of theoretical interest that crescents were part of the Clovis inventory in the Mojave Desert but were not transferred out of the Great Basin to areas east of the Continental Divide. There was an ecological reason for this anomaly.

True crescents (which will be separated from "crescentics" in a later subsection) have a 1:1 relationship with water (Davis 1973:21) in all parts of the Great Basin where we have had opportunity to observe them in context. They may well have been a skip-water variety of missile, launched at water level against such large waterfowl as goose, brant and swan. If this proposition is correct, the crescents would have been useful hunting implements throughout the Lakes Country, but less useful east of the Rockies. They serve to distinguish western Clovis from eastern Clovis. In the west, a Classic Clovis toolkit[4] would be as follows:

a) Crescents
b) Crescentics

[4]This list is peculiar to Classic Clovis only. It does not necessarily conform to Table 5.

c) Flake cutters
d) (Possibly) needle-tip knife/points with concave bases (Fig. 31f)
e) Fluted knife/points with either parallel-sided or ovate bodies
f) Ovate bifaces (preforms?)—scarce
g) Unfluted, lanceolate knives or preforms with square bases
h) "Slug" scrapers, keeled, bipointed (*limaces*)
i) End scrapers
j) Side scrapers
k) Spokeshaves
l) Saws
m) Shredders
n) "Steak knife" slicing flakes (numerous)
o) Choppers
p) Pounding/grinding rocks
q) Broad beaks
r) Broad beaks, curved
s) Broad beaks, triangular
t) Spur beaks
u) Spur beaks, single
v) Spur beaks, double
w) Spur beaks, multiple
x) Unmodified flakes used for many tasks

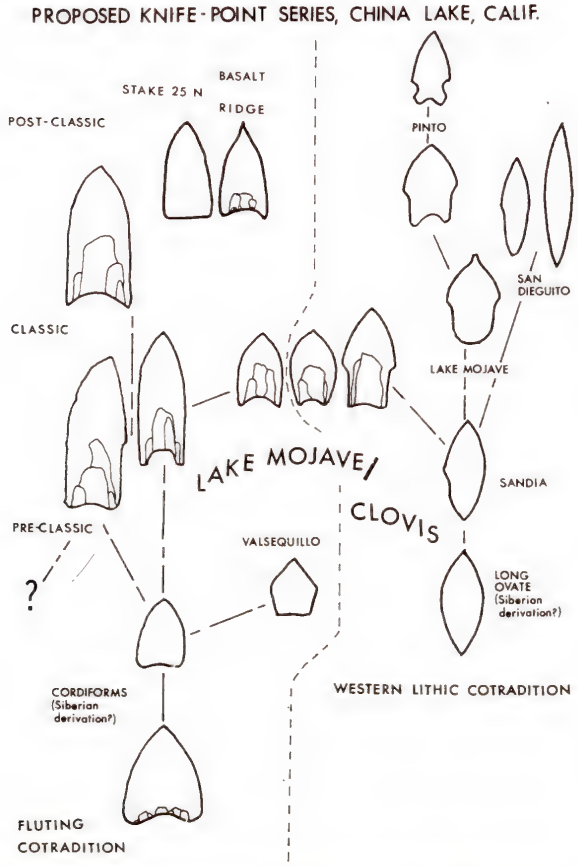


FIGURE 32. Proposed knife/point series, China Lake, Calif. It now seems likely that cordiforms rather than ovates are the oldest forms. This remains to be determined.

5) *Folsom.* East of the Rockies, Folsom bison hunters refined weapons and tools of the Fluting Co-tradition still further, producing knife/points that were technological masterpieces (Crabtree 1966:3; Judge 1973: 168). However, Folsom diagnostics have not so far been discovered on sites in the Lake China basin. Perhaps by this time, the Lakes Country was too arid.

On the other hand, expanding grasslands of the Great Plains and New Mexico river valleys appear to have afforded prime ranges for increasing herds of bison, which were preferred targets for Folsom specialists. These hunters were general foragers, but also they were expert killers and butchers whose sophisticated tools were the historical terminus of the fluting technologies.

GENERAL ARTIFACT DESCRIPTIONS, CONTINUED

11) Scrapers

"Slug" scrapers are long in proportion to their width (note dimensions in Fig. 33c-f) and also are thick, with a keel on the long axis of the dorsal side. Some have two working edges and a rather sharp nose; others are shaped at the ends to form chisels, or end scrapers in addition to the two sidescrapers. Some slugs are weathered heavily. If weathering is a significant criterion of age in the Lake China basin (a matter which is discussed pro and con at the end of this chapter), then the slug scraper came into use far back in the postulated Late Wisconsin Cultures. But if weathering of these artifacts is not a reliable criterion, then other causes and associations must be sought (see also Fig. 9A,d; and Fig. 36a-b). Figure 33a, c-f illustrate a number of slug variants.

Round-end scrapers.—These are transverse in plan, with the working edge set normal to the stem (if hafted) or to the direction of work. They probably were pushed *away* from the worker, but no wear patterns remain to clarify this question. Most end scrapers have a convex working member, with a moderate rake angle, at the distal end of an elongate tool. Round end scrapers in the Lake China assemblages occasionally have a spur beak at one corner of the arc. Judge (1973; Fig. 11) reports this same configuration in end scrapers from Folsom sites in New Mexico.

The end scraper subclass of work tool may be very ancient in the Lake China valley. Fig. 34a-i illustrates a number of degrees of weathering and of technical sophistication. Fig. 34a-b can be attributed to an early Core Tool Tradition (Table 7). Fig. 34i is Classic Clovis.

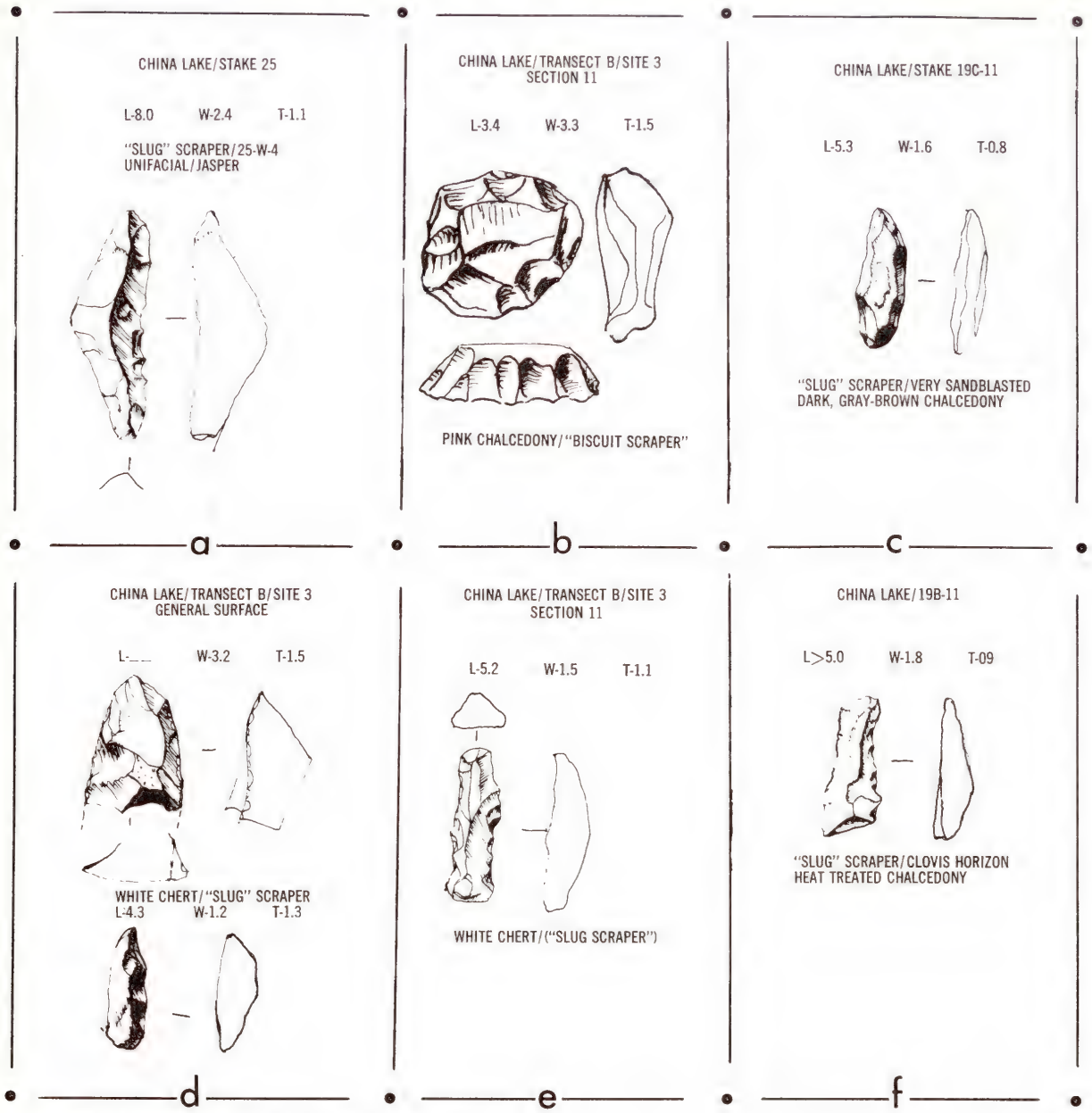


FIGURE 33. b) biscuit scraper; a, c-f) "slug" scrapers.

It also is illustrated (though less crisply) in Fig. 12a. Another end scraper, which may be attributed to hypothetical Late Wisconsin Cultures I, is shown in Fig. 9A, a and e.

Biscuit scrapers.—Round or ovate in shape like biscuits or cookies. Made from segments of thick flakes, they are shaped around on all sides, usually at a steep angle of 45° or more. They sometimes occur as extremely weathered specimens and may be attributable to the hypothetical Core Tool Tradition (Fig. 8b is the eroded wreckage of a biscuit scraper, which probably had a spur beak on the left side). Fig. 8d is another biscuit scraper made of jasper, heavily weather-worn and with the stub of a spur beak on the right side. Figs. 33b; 35c and 36c-d illustrate biscuit scrapers.

Side scrapers (lateral scrapers).—These are a catch-all class and include all straight working edges, which could be used for light chopping tasks, blunt cutting tasks (see Table 5) or general scraping of animal hides or fibrous plants. In the Lake China flake tool assemblages, side scrapers occur in all sizes and shapes. A special study should be made of the variations and means of rake angles in these all-purpose tools. (See Fig. 35a-b).

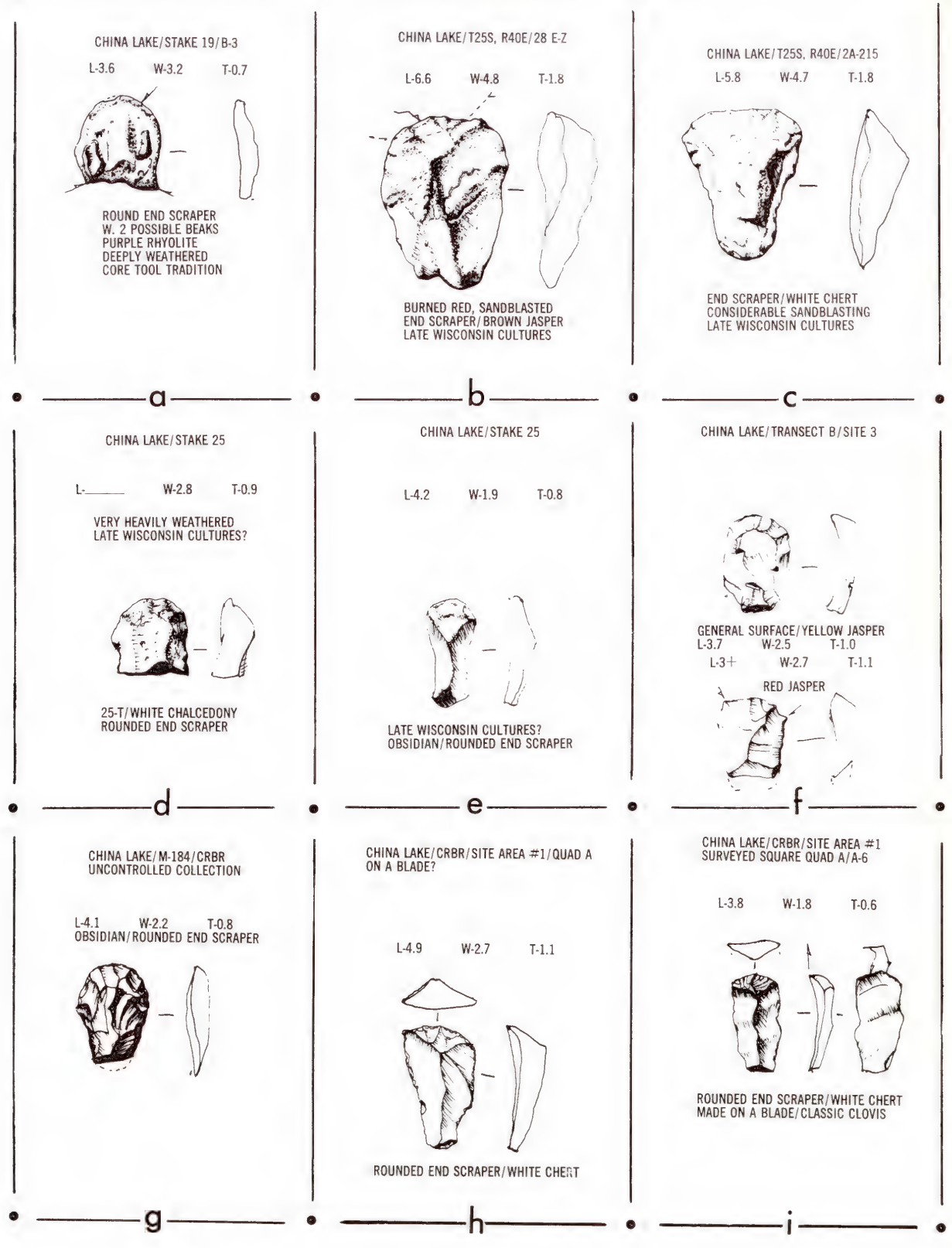


FIGURE 34. a-i) round end scrapers.

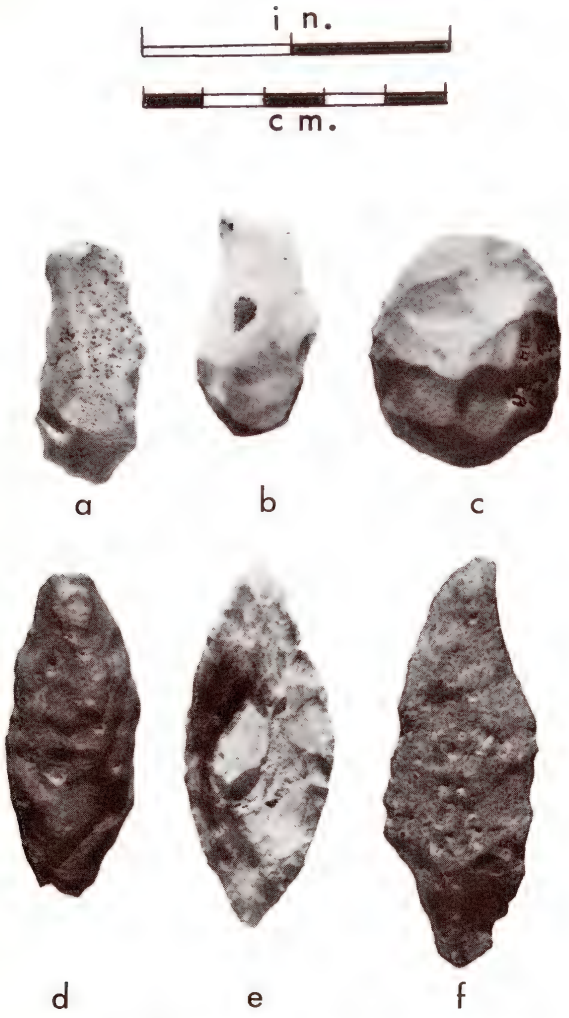


FIGURE 35. a-b) 2 small, double-edged side scrapers with spur beaks; [(a) is broken]; c) a biscuit scraper; d-f) long ovate knife/points Late Wisconsin Cultures I; e) thinned long ovate knife/point, possibly contemporaneous with Classic Clovis.

FIGURE 36. a-b) "slug" scrapers; c) biscuit scraper with spur beak (upper edge); d) biscuit scraper with eroded spur beak and heavy weathering.

Spokeshave scrapers.—These vary from gently concave to deeply recessed, depending on whether they were produced for peeling or sizing wood. They constitute an unusually informative tool class in the Lake China collections, giving clues to the possible existence of basketry and wicker work long before any of the manufactured products could have survived.

Like the roots of milling, basketry roots may measure back into the Pleistocene. Since chimpanzees knit and purl branches into nests for themselves, it seems reasonable that humans should have been making cordage and baskets for a very long time. Those spokeshaves shown in figure 37a-e (particularly a) would have served well for sizing unusually slender wands, wythes and roots, suitable for textiles or light cradle packs. They are the first indications we have seen of possible Proto-Clovis and Clovis textile technology, which might reach back into the hypothetical Late Wisconsin Cultures (Table 9).

Fig. 37f is a multi-radius spokeshave, a composite tool (see also Fig. 9B, a). Fig. 37d has an arc so shallow it could have been used for beaming small hides over a curved surface. Fig. 37g is a combination of a micro-spokeshave and two side scrapers.

12) CHOPPERS

If it can eventually be demonstrated that bands of human foragers were making their way into the New World as early as 40,000 or 50,000 years ago, we should find choppers to have been among their tools. Movius (1949) defines the choppers of eastern Asia as large, heavy scrapers. Mojave Desert choppers, from early to late, fit this description well. Choppers were used as heavy duty butchering tools, judging from the occurrence of a chopper among the bones of Mammoth no. 1, and a fragment of another chopper with mammoth and camel remains on the north shore of Stake 22 playa (see Chapter 5). By assembling diverse information from Lake China sites, a PaleoIndian series of butchering tools can be proposed as shown in Table 5,

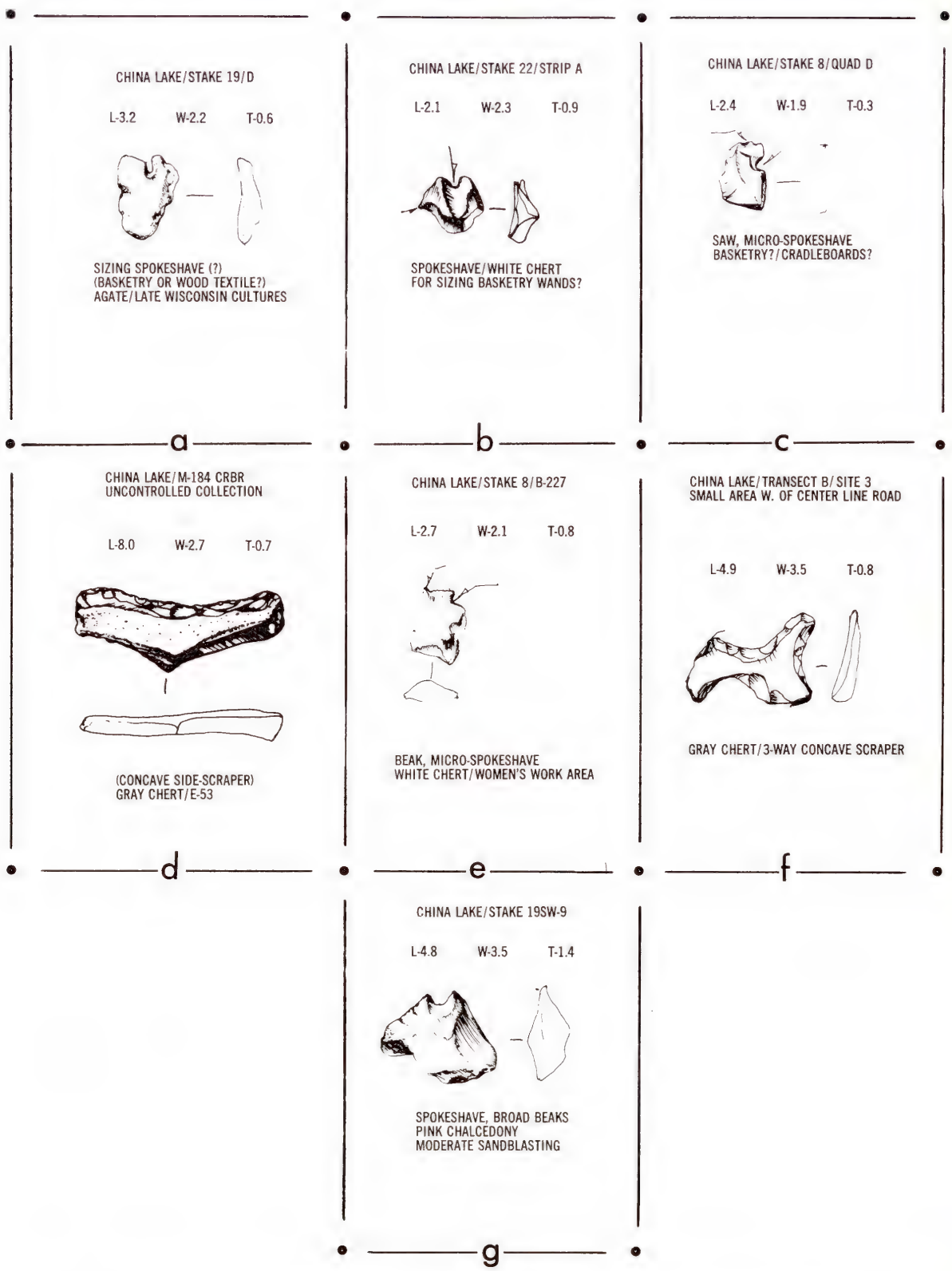


FIGURE 37. *Spokeshaves:* a-b) microspokeshaves suggesting basketry and wicker work; c, e) small spokeshaves for basketry, wicker, and little wooden implement manufacture; d) is an extremely shallow arc with two dorsal edges which are not retouched. Clovis? f) is a multiple radius tool; g) microspokeshave with two side scrapers.

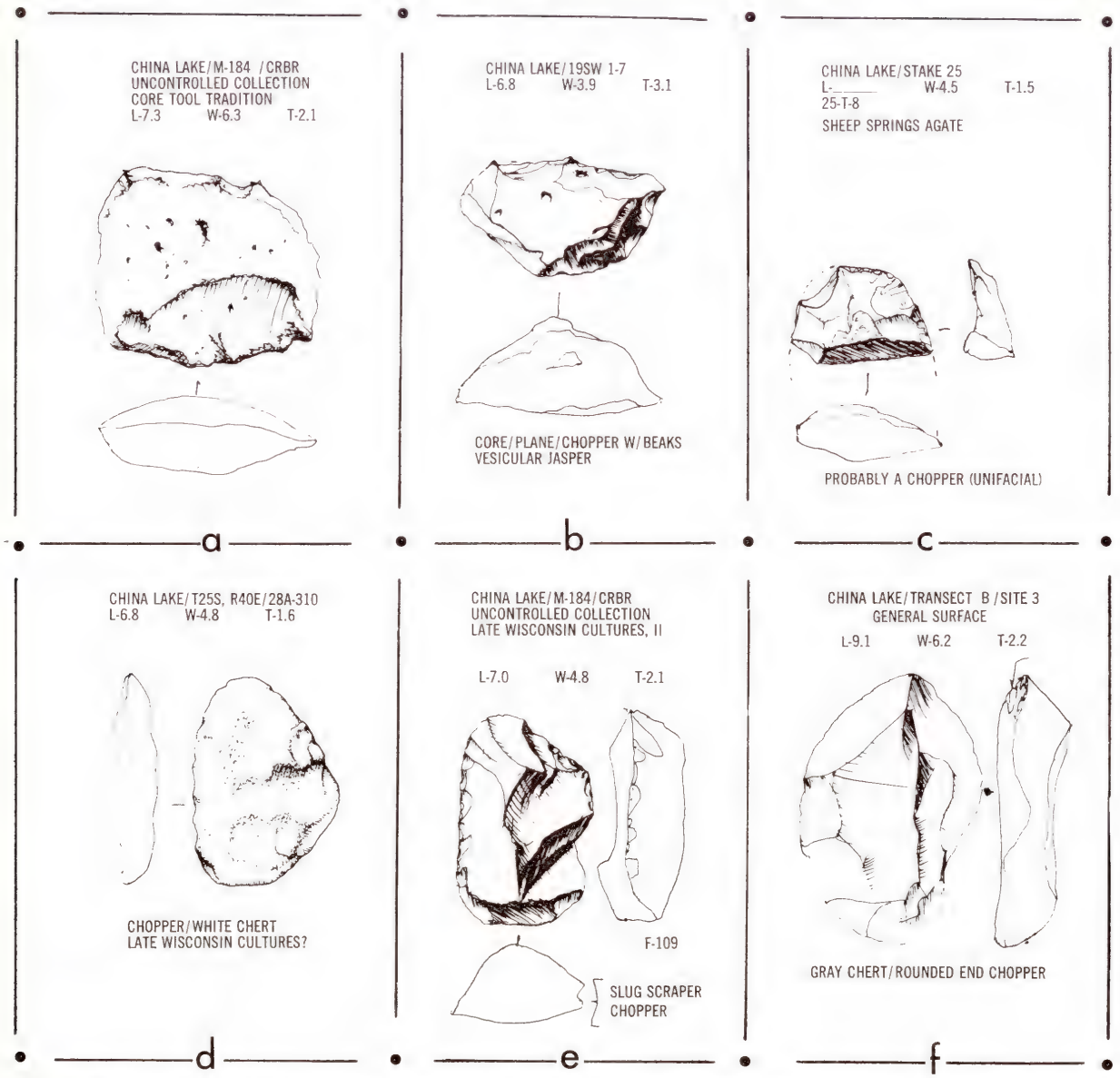


FIGURE 38. *Choppers:* a-f) (a) is attributable to an ancient Core Tool Tradition. Choppers are ubiquitous on all sites and, probably, during all periods.

from choppers to "steak knives." Choppers were ubiquitous over time and across cultures. Choppers are shown in Fig. 38a-f.

13) Spur Beaks

Spur beaks are numerous in all the site collections, appearing as singles, doubles, multiples and adjuncts of composite tools. They fall into two morphological classes: acuspurs, often as sharp as little needles and suitable for piercing (Fig. 39-top right, center, lower left); and stub spurs that are broader and stronger, better adapted for graving (Fig. 39-top left and lower right; Fig. 40a-d).

Stub spurs are found most frequently on weathered tools and are probably an older form than acuspurs, which are characteristic of late PaleoIndian assemblages.

14) Broad Beaks

These are both wider and longer than spur beaks, although the two classes intergrade as can be seen in Fig. 40d. The examples in Fig. 41a-c, are thick and sturdy but short. They could be sorted toward either the broad beak or spur beak (stub variant) classes. It is interesting that stub beaks of this type, and with a handhold grip, are among the most extremely weathered artifacts in the valley.

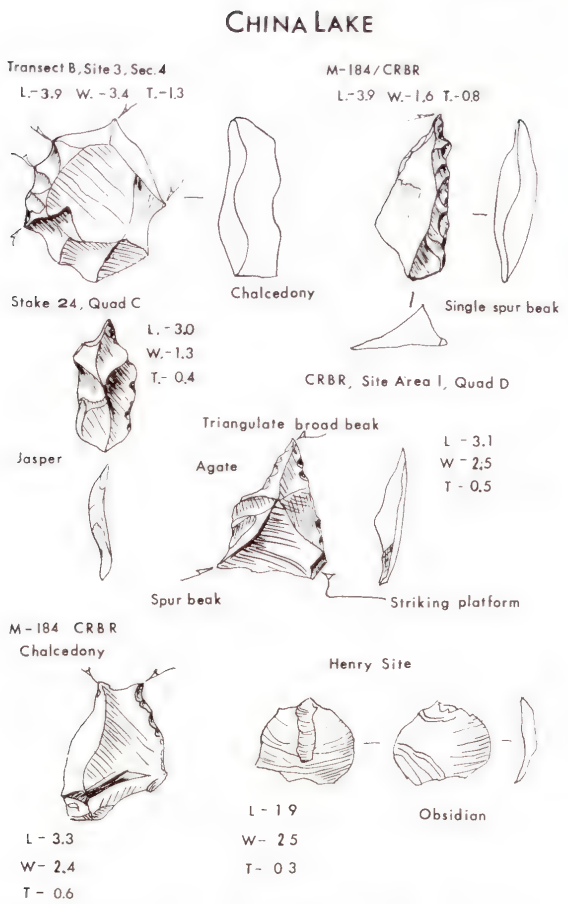


FIGURE 39. *Beaks:* top right, and second left—acuspurs; second row right—broad beak, triangular; top left and bottom row —spur beaks.

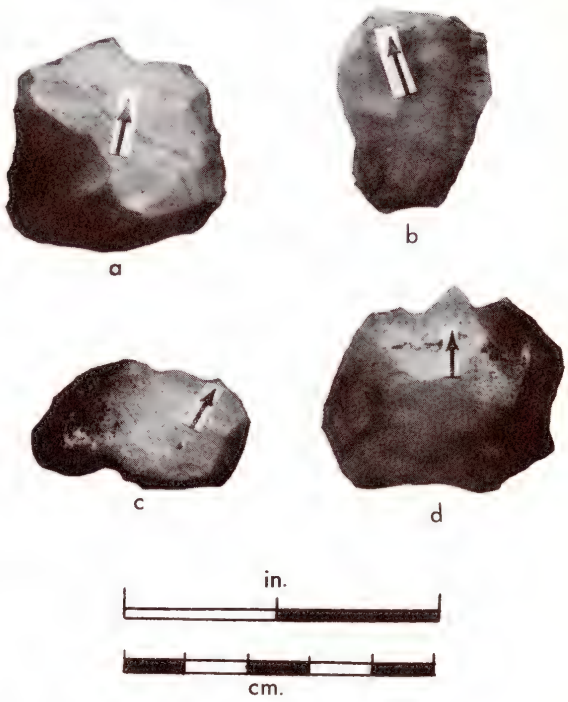


FIGURE 40. (a) is a biscuit scraper with a spokeshave (arrow) and a spur to the left; (b-c) are flake tools with worn stubs of acuspurs (arrows); (d) could be classed as either a spur or a broad beak. All specimens are from Stake 25.

shown in Fig. 12c. It is attributable to the Classic Clovis phase. Another important subclass of broad beaks is a long borer, (Fig. 41d-f). Some specimens have a chisel tip (Fig. 41d and e). The last subclass of broad beaks is a triangular type, shown in Fig. 39, center. These have needle sharp distal tips for scribing or scratching and are shaped on flakes, which expand rapidly toward the proximal end. They were probably hand-held.

In the Long Count hypothesis of Lake China cultural chronology (Table 9), broad beaks are considered to be components of a Core Tool Tradition inventory.

15) SMALL FLAKE CORES

Such cores are scarce because of the parsimony of lithic economies in this valley, and cores in general have been exhausted—reduced to nubbins, which could no longer be securely held. Some of the flakes produced by these industries are so small as to suggest the existence of rather complicated, compound tools (such as saws) made up of sharp little flakes set into a handle with mastic.

16) CRESCENTS

Crescent-shaped hunting weapons already have been mentioned as parts of a Classic Clovis toolkit in the Lake China region. There is reason to believe that crescents are much older than this, judging by their distribution, morphology and weathering.

Crescent-shaped objects are characteristic of western sites, *but only in one context:* proximity to water, particularly lakes and marshes. In 1962, Davis wrote to Richard Shutler and H. M. Wormington, pointing out this 1:1 correlation of true crescents (as opposed to the work tools called "crescentics" in this report) with extensive bodies of water and proposing the use of at least some of the crescent forms as lateral weapon tips for hunting large waterfowl. This association is discussed again at the Hord Site (Davis 1973:21). The Hord Site is a PaleoIndian camping and quarrying locus near a mountain pass. Prediction for this location was that no crescents would be found because the area offered no waterside hunting.

Crescents are ubiquitous throughout western intermontane basins from the Lind Coulee Site in Washington (Daugherty 1956:223) to southern California (Campbell

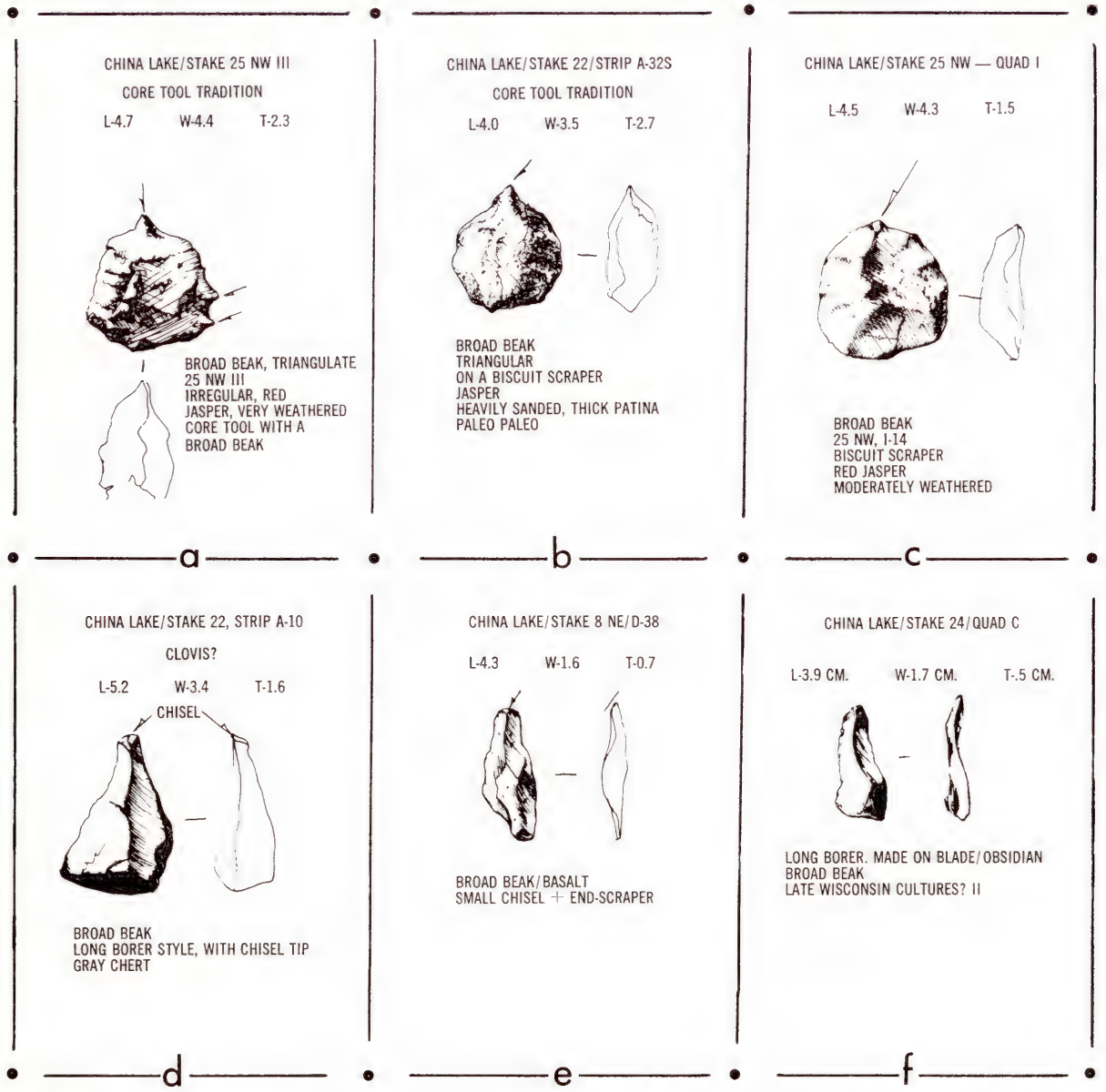


FIGURE 41. *Broad beaks:* (a-c) are wide and thick; (b) can be classed as triangular; (d-e) are long borer style broad beaks with chisel ends; (e) is an example of the simple, long borer subclass.

1937; Warren and True 1961). In the Lake China basin, they are widespread, although not universal in the localities we have mapped or tested. Some sites have no crescents whereas others have many and we have as yet no well structured explanation for why this should be so. Eventually we may find that crescents have associations with former swamp areas, still discernable in the eroding landscape. Such areas are found near Stakes 19 and 13, two test squares that produced the highest proportion of crescents.

Crescents possibly were introduced during a Late Wisconsin Cultures I phase and continued in use, with increasing elaboration of form and technological sophistication, through Lake Mojave, and Proto-Clovis, Classic Clovis and Pinto phases. After this, their use was discontinued, *probably because of extinction of the habitats in which they were useful,* about 7,000 years ago. This paleoecological explanation seems most useful.

Because of their long span of use, Lake China crescents also have many degrees of weathering from extremely eroded (Fig. 42b) to virtually mint condition (Fig. 43a-c). Fig. 11A, top, is an example of a Classic Clovis butterfly crescent that is only slightly sandblasted.

Morphology and use of crescents.—Tadlock (1966: 662) published a study of three types of crescents from

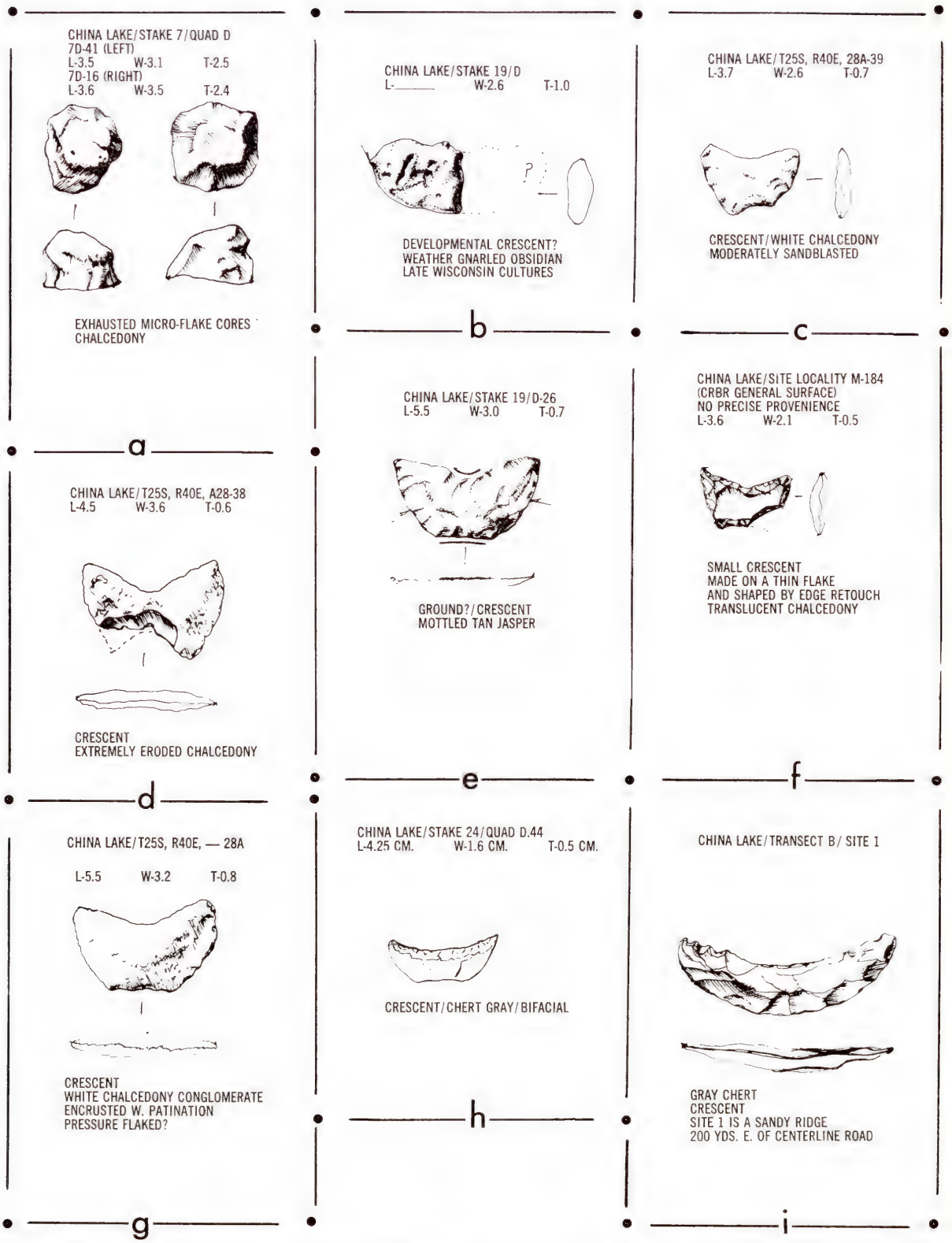


FIGURE 42. *Small flake cores:* (a) is an exhausted microflake core. *Crescents:* b) possibly a crude, ancestral form; c-g) butterfly forms; h) was probably an ornament or amulet; i) is a quarter moon shape; it is called a long lunate in this report.

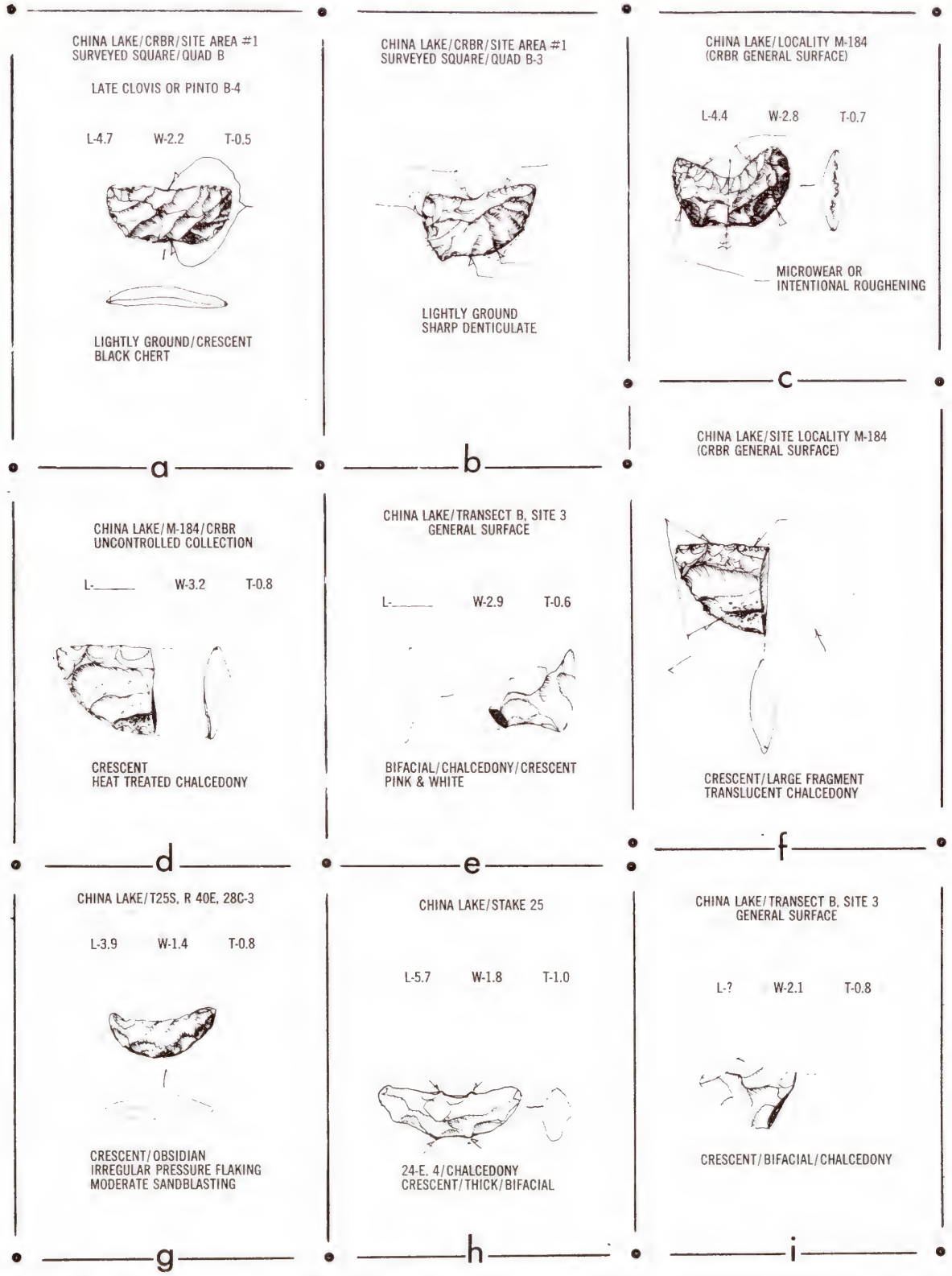


FIGURE 43. *Crescents:* a-d) late(?) butterfly forms—Clovis or Pinto?; e-f) fragments of similar large half moon forms; g) fragment of a long lunate form; h-i) quarter moon forms.

Long Valley, Nevada, and discussed distributions of such artifacts as known at that time. We visited Long Valley with the Tadlocks in 1962 and saw these tools in secondary deposition on the floor of a deep blowout. They seemed to have eroded out of deposits of lacustrine silt, still visible in a few, free-standing columns. This situation reinforces a cultural inference of their use in waterside hunting of large birds that could be disabled (while feeding) by a heavy blow from one of the wide, flat crescents, attached to a rather ponderous shaft and *possibly skipped on the water at the moment of impact.* This particular suggestion implies functional qualities in the design of the flat butterfly wings . . . and it suggests the use of an atlatl.

Tadlock (1966:663) defined three types of Long Valley crescents, based on their silhouette morphology: Type I, "quarter moon"; Type II, "half moon"; Type III, "butterfly." All these variants are illustrated in Figs. 42b-i; 43a-i; and 44a-f. In addition, the Lake China collection contains a single specimen of a very long, delicate object (Fig. 42i), too fragile for use, and notched at each end to receive a cord. It was, perhaps, an ornament—a pectoral belonging to a special person.

Technically, Lake China crescents have a wide range of variation in flaking, which is in contrast to the more uniform collection from Long Valley (Tadlock 1966, Figs. 3 and 4; Table 1). The Long Valley material appears to be much more a cultural and temporal unit whereas the widely distributed crescent population of Lake China sites represents both temporal and cultural variety. Lake China tools of this class vary in technique from a few made by rough, haphazard percussion (Fig. 42b, h) to others which have been shaped by careful, pressure flaking (Fig. 43a-c).

Weathering of crescents also has a wide range of variation, but correlates with technology in the same consistent manner peculiar to all artifacts from these sites: extreme or heavy weathering is found on tools that have been made by haphazard, percussion flaking whereas pressure flaked objects are, at most, only slightly sanded.

Opinions about uses of crescents vary through a wide range of possibilities. Amsden (1937:51) and Wardle (1913:656) proposed that, because crescents sometimes have little spurs at the top and bottom edges, they could have been used as primitive surgical instruments, for incising cicatrices or to tattoo patterns in the skin. Some of the Long Valley specimens that I inspected also had minute denticulations along the wings, and could conceivably have been used for refined slicing or skinning. Perhaps, like many of the tools in Lake China inventories, crescents substituted for several jobs. Also, there are a number of different crescent patterns, of which the specific uses (the morphology/function correlates) are not understood.

We suggest that when our collections are restudied in relation to site cluster distributions on the plane table maps, we may learn something about the reasoning that underlies different basic plans or templates of crescent design. Intensive study of individual specimens also will be revealing. As an example, the butterfly form in Fig. 42e has some interesting features (noted on the card) as follows: a) the deep concavity (at the top of the drawing despite its probably having been on the base—the proximal side—of the missile) appears to have been ground; the sides of the wings were sharpened; and the lower arc (in the picture) was used in such a way as to produce slight battering.

This bruising of the stone leads one to think that the lower arc was actually the leading edge of a missile, a projectile of some sort with other, secondary uses. If the projectile hypothesis is correct, then a haft, (a foreshaft or handle), was lashed into the deeper concavity, and the missile was launched at a swimming goose, let us say, with the two wings pointed backward. In this position, the wings would allow this unique projectile to glance or skip should it touch the water before striking the bird.

To summarize various opinions about crescents, they have been proposed as:

1) Lateral bird bunts,
2) Surgical instruments,
3) Skinning or slicing tools,
4) Ornaments or amulets,
5) Specialized scrapers,
6) Special implements, capable of glancing off the water when used against waterfowl.

17) Crescentics

The list of interpretations of crescents given above leads to still another possibility—some crescentic forms are neither weapons nor ornaments but work tools for peeling or stripping. Many of these overlap with weapon-crescents morphologically and, therefore, are called "crescentics" in this report. The concept of using crescentic flakes for peeling willow shoots (basketry and textile); stems of Indian Hemp (*Apocynum*) for cordage; or wooden staves for handles—was adopted from Margaret Wheat's *Survival Arts of the Primitive Paiutes* (1967:56 and 95). This book is a gold mine of information on technologies of Great Basin perishables.

The crescentics shown in Fig. 44 actually are not the best examples in our collection. They merely happened to have been put on analysis cards with the understanding that they were aberrant forms of crescents, and originally they were filed under that rubric. Two very excellent examples of the crescentic work tool class, however, are presented in Fig. 23b, e. These and other artifacts in Fig. 23 are from a tiny, isolated site in Stake 8A, which was very likely a women's work area. These two crescentics are composite tools—Swiss Army knives of the

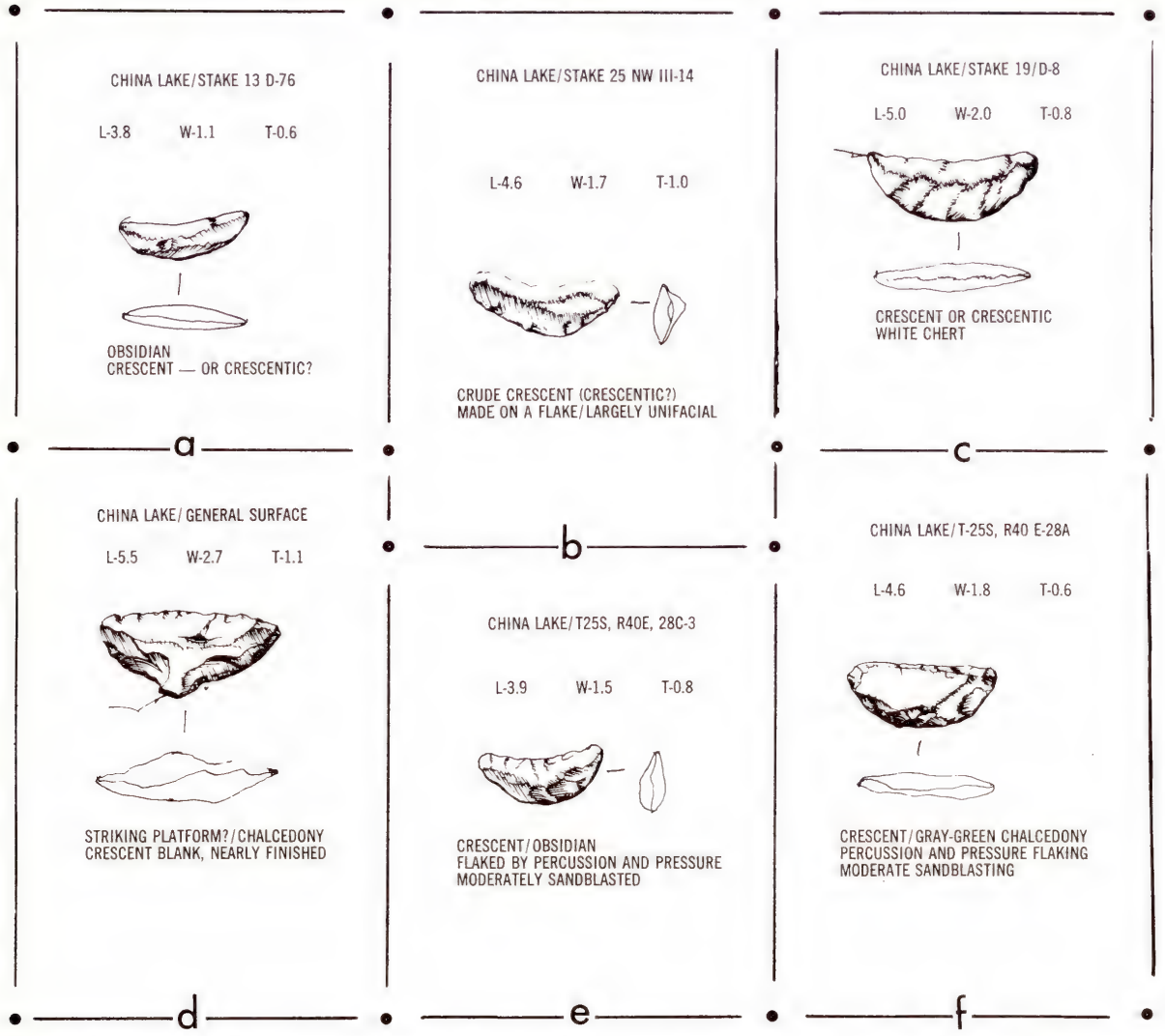


FIGURE 44. *Crescentics:* a) crude crescent or crescentic scraper; b) crescentic scraper on a flake; c) bifacial crescentic with spur beak in left tip, a chisel in the other; d) crescent blank or crescentic on a side-struck flake; e) crescent with a break beak at each end, a work tool; f) chalcedony crescentic.

American Upper Paleolithic. Many are designed for scraping, peeling, trimming, incising, gouging and sawing. Women probably worked at a variety of tasks with a number of materials, including stone. That is, women made their own tools for making tools.

Although the Stake 8A toolkit is moderately weathered, the working elements can still be seen: Fig. 23b has two spokeshaves in line along the top, a beak of a different size at each end and worn stumps of saw teeth along the bottom. Fig. 23e has stubs of two acuspurs at the top, left. These are flanked by a short side scraper edge. Each end has a weathered beak and traces of a saw can be seen on the lower edge.

Crescentics often are unifacial, made on irregular flakes, and were evidently handheld whereas some crescents were designed to be securely hafted on a foreshaft or staff.

18) Long Ovate Knife/Points

Weapons of this conformation are proposed to have been one of the two Asian types of knife/ points, which were originally brought to the New World. This is a testable hypothesis. Ovate points in these collections are shown in Figs. 45 and 46. Some are bipoints whereas others have nascent stems and shoulders. Weapons of this type are consistently more weathered than other types. If the relatively soft obsidian and rhyolite specimens are discounted, this still remains true of specimens

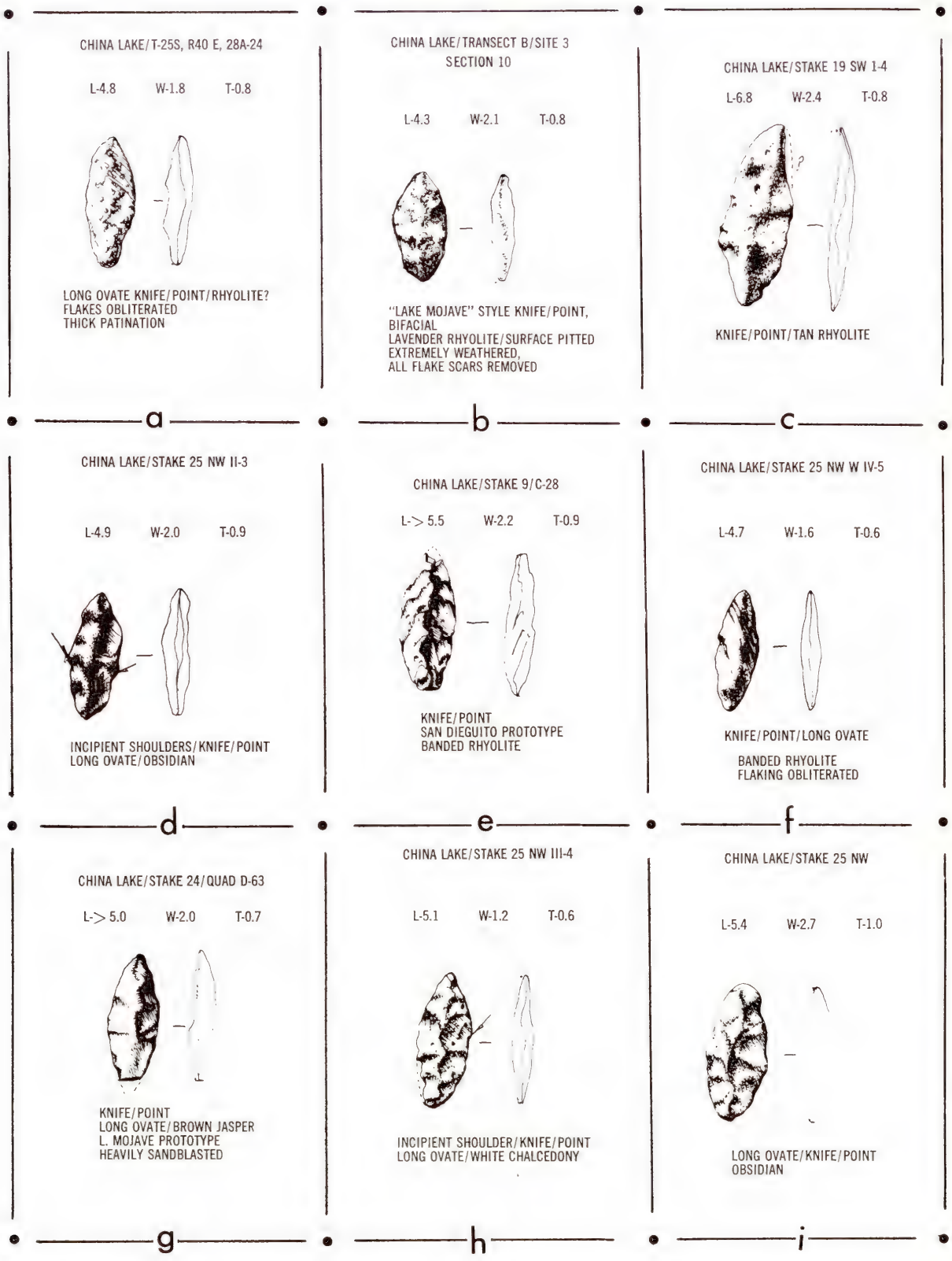


FIGURE 45. *Long ovate knife/points* (Late Wisconsin Cultures, I?): a-i) early forms, weathering is heavy to extreme. Ovate bipoints are consistently the most weathered weapons in the valley.

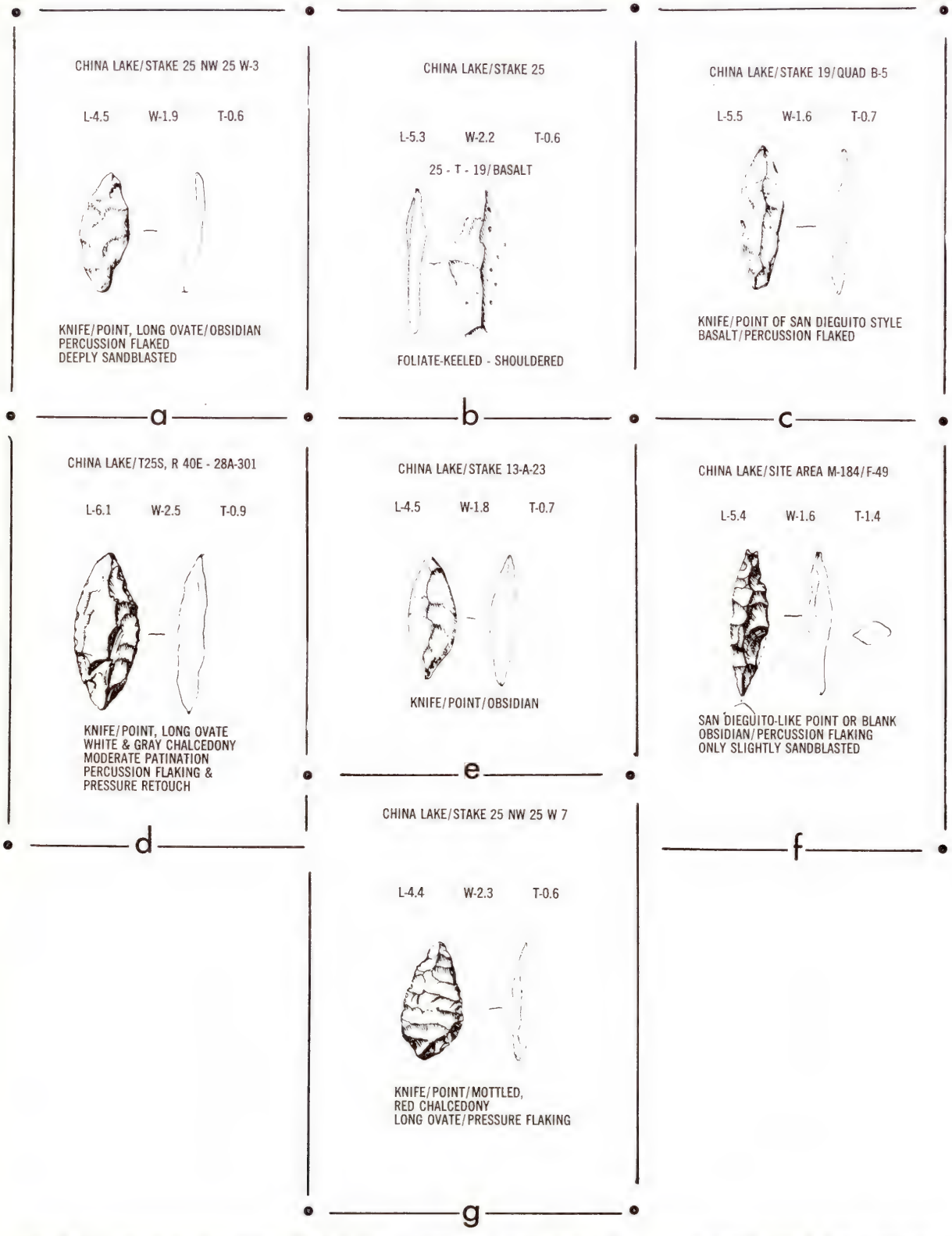


FIGURE 46. *Long ovate knife/points* (Late Wisconsin Cultures II—San Dieguito?): a) Heavily weathered bipoint with 1 shoulder; b-c) San Dieguito weapons, heavily weathered; d), g) late ovate bipoints; e) knife point with 1 shoulder; f) San Dieguito blank.

made from harder silicates like jasper and chalcedony.

Not only are long ovates more apt to be eroded than are knife/points of Clovis, San Dieguito, Lake Mohave and Pinto styles, but most are technologically different. The long ovate bipoints shown in Fig. 45 are all manufactured with somewhat irregular, percussion flaking. Compare this with more regular percussion in Fig. 46d, f, or the even pressure flaking shown in Fig. 45g.

It seems likely that both stemmed and shouldered Lake Mojave weapons, and more specialized San Dieguito/Lerma styles were later developments from the original long ovate forms. One good reason for the persistence of a long ovate pattern is its sturdiness, so long as a rather narrow and thick cross section is retained. As a comparison, all the lanceolates in these collections have been snapped off at midpoint or else at an interval slightly distal to the faint shoulder. The long ovates are seldom broken. The tips are sometimes damaged by weathering or subsequent accident. Midsection breaks are virtually unknown.

These are thrusting weapons whereas the knife/points of lanceolate pattern are cutting weapons.

In summary, there evidently are three reasons, two mechanical and one social, for the persistence of long ovates.

1) The basic design is compact, with no weak spots.
2) It is torque resistant due to the relatively thick body and the small moment associated with that body's comparative narrowness.
3) It appears to have been a long established custom to use the ovates primarily as piercing instruments (true points) rather than as knives for dismembering and prying.

19) Stemmed Knife/Points; Knives; Points; Bunts and Cutters

There are several items of unusual interest illustrated in Fig. 47. Fig. 47a is a large obsidian knife, with a stem and two shoulders—but also two flutes. It is a good illustration of a contact between two Co-traditions in the Mojave Desert; the Western Lithic Co-tradition (comprising Long Ovate, Lake Mojave and San Dieguito components) and the Fluting Co-tradition made up of the Proto-Clovis long knife Tradition and subsequent Classic Clovis Tradition of fluted knife/points. (See Figs. 10; 30-32).

The specimen illustrated in Fig. 47b has a blade with one straight edge and one curved edge; there is also a single shoulder characteristic of one of the Lake Mojave types of the Western Lithic Co-tradition (Davis, Brott and Weide 1969)—but also characteristic of Sandia knife/ points, which have a relationship with the Fluting Co-tradition. Knives with unilateral, curved sides would be good skinning implements, like an Eskimo ulu.

Figure 47f is of major importance. It is the only bifacial, diagnostic tool found at the Henry Site (Chapter 5).

It is part of the inventory of a site where there is secure association of people with horse and camel.

The rest of the inventory tells us that this was a processing camp (probably with a tent or shelter) where meat was sliced with unmodified flakes and roughly modified flake cutters. FOUR OF THESE FLAKES HAVE DISCERNABLE USE-SCRATCHES IN SEVERAL DIRECTIONS; these directions can be reduced to a fairly narrow fan.

The bifacial specimen originally was classed as a knife/point, but is more likely to have been used as a knife, judging from the fact that it is slightly curved in the sagital plane, is wide and blunt, and has a spur on one side, making it a poor instrument for penetration.

Fig. 47i probably is also a bifacial cutter with a spur at the distal end.

20) Pinto (?) and Late Artifacts

Fig. 48a-c are associated with ill-defined activities of a phase that is classed under the general rubric of Pinto. Large knife/points of this design (tri-notched) and technology (even, diagonal pressure flaking) are more common in the vicinity of the Basalt Ridge than elsewhere in our test areas. They occupy the same surfaces as fragments of mammoth, camel and horse but the association is dubious.

Hunt (1960, Fig. 24) classes tri-notched knife/points as components of a Death Valley II assemblage, which she estimates to have lasted from early Recent (Holocene) millennia to a Recent Pluvial episode (1960, Table 1). At China Lake, their position is still unknown, and our best clue to their relative age may be their relation to the dated soils at Stake 1, Trench 3, and at the Basalt Ridge. Hunt (1960, Fig. 24) groups tri-notch-points as Death Valley II—about 3,000 BC.

The specimens in Fig. 48d-f and h are comparable to "long bladed arrow points" from the Death Valley salt pan (Hunt 1960:111; Figs. 40, 41). This segment of Hunt's material is classed as Death Valley III, estimated to have a date of about AD 1, at which time a pluvial episode had flooded Death Valley with a lake 30 feet deep. It is reasonable to suppose that the same pluvial restored enough water and grass to the dry basin of China Lake to make it inviting to occasional small bands of late Indians, who may have used the environment as a winter range for hunting and gathering.

Knife/points like the object shown in Fig. 48g are of uncertain cultural affiliation. Two have been found at the Rock Pile Site near Basalt Ridge, in clear association with bone and lithic debris and fragments of tooth enamel of mammoth, camel and possibly horse. These

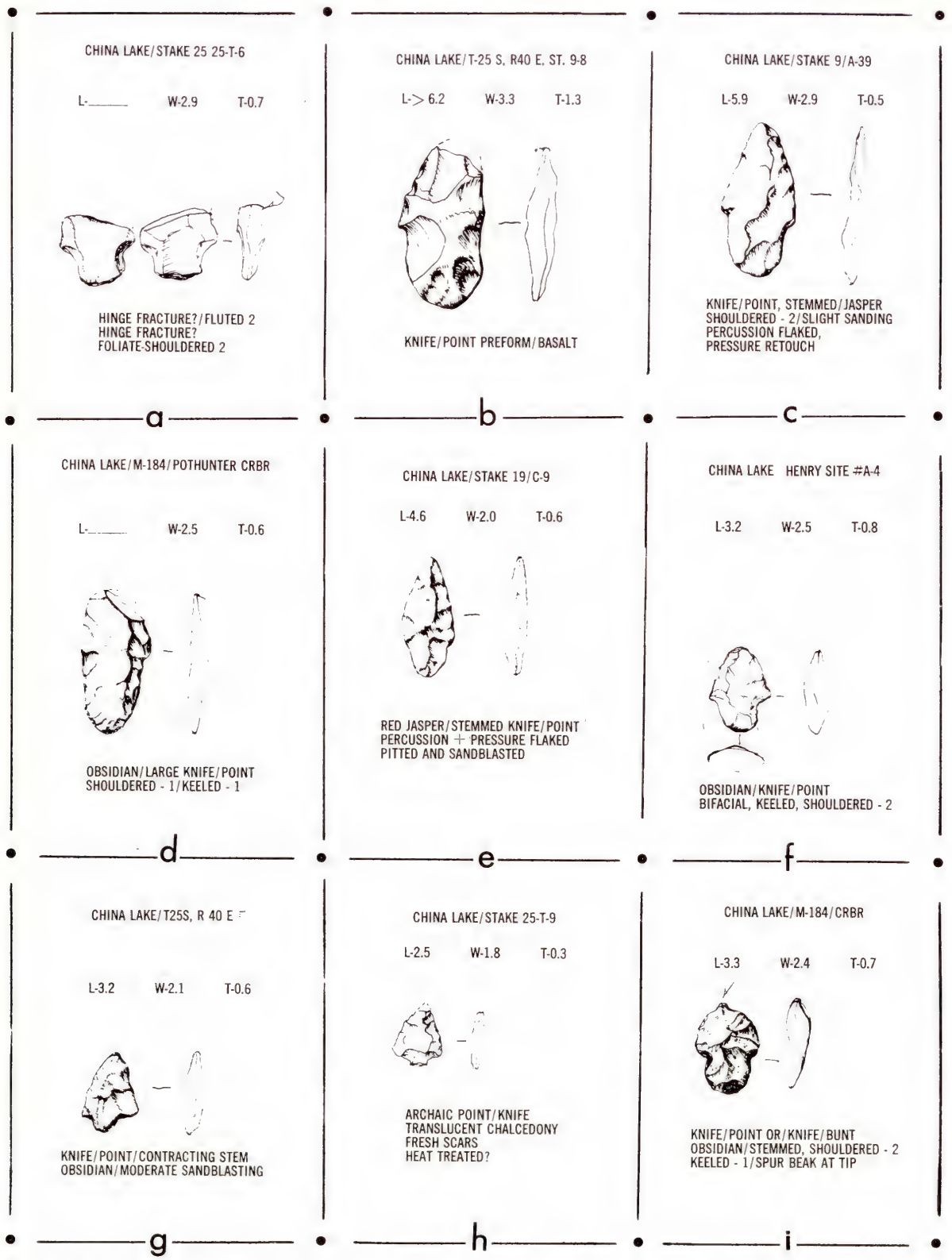


FIGURE 47. *Knife/points,* stemmed (Transitional and Lake Mojave)—10,000–11,000 years B.P.? a) a large, stemmed knife or knife/point fluted on both sides; b) large knife with 1 shoulder; c), e) Lake Mojave points; d) large knife or knife/bunt with 2 incipient shoulders; f), g), i) are bifacial cutters with 2 shoulders (all are curved on the long axis).

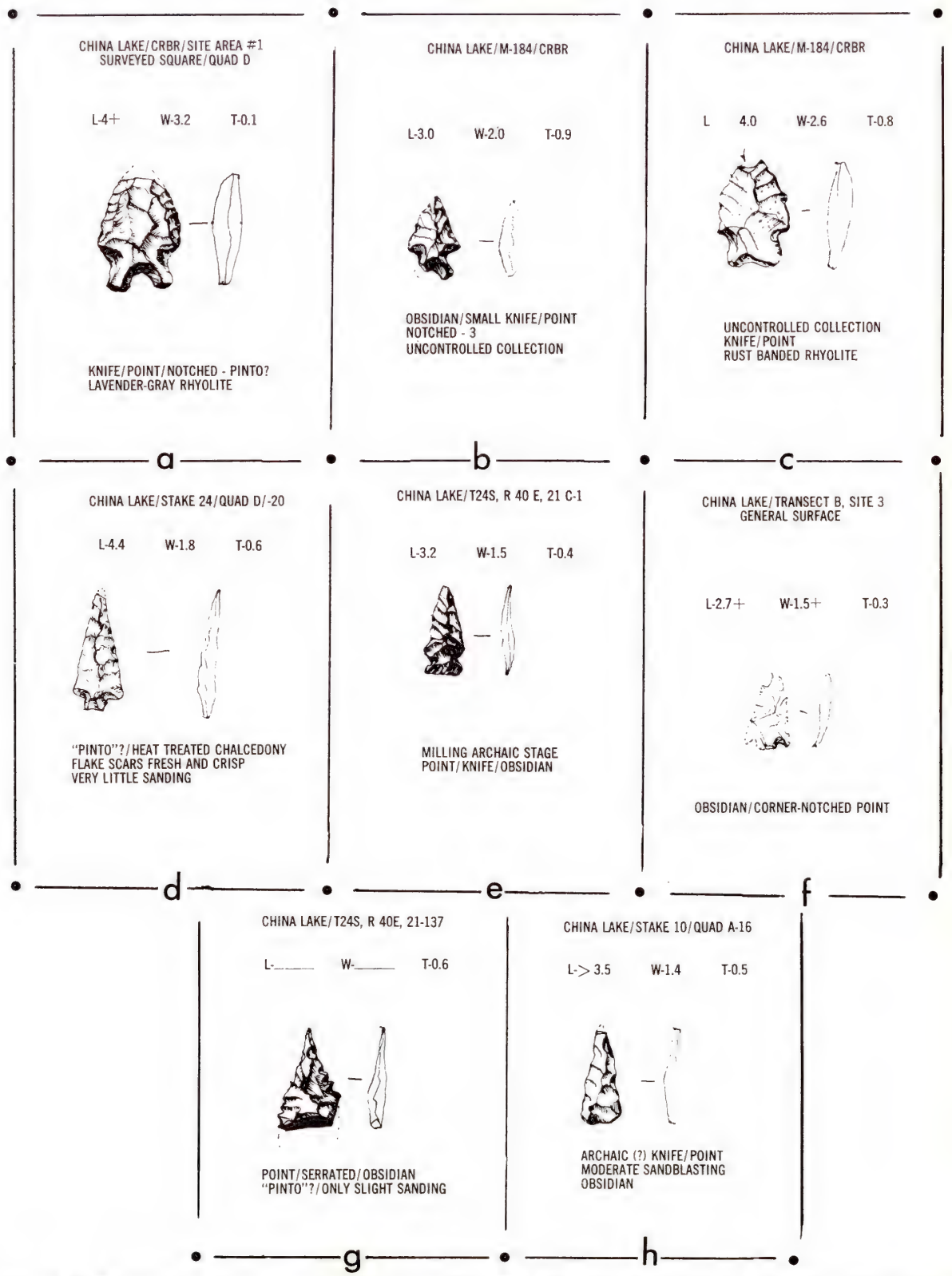


FIGURE 48. *Knife/points, notched and serrated (Pinto?):* a-c) Pinto Phase (?), tri-notched knife/points; g) possibly a Pinto hunting weapon; d), e), f), h) early Milling Archaic dart points.

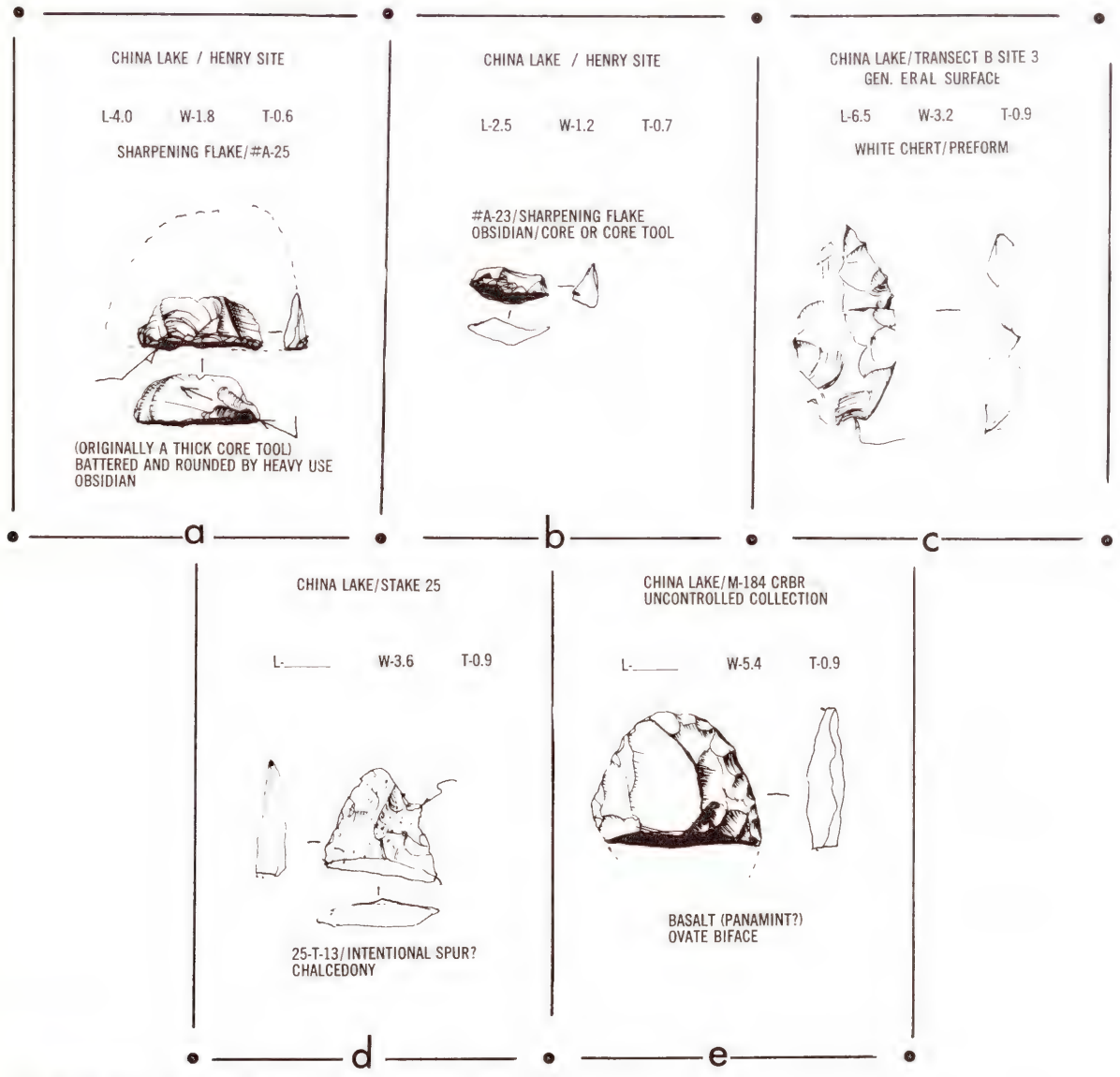


FIGURE 49. (a-b) *Sharpening flakes*. (c-e) *Ovate bifaces*.

weapons clearly are designed for killing and are needle sharp at the distal tip. They also have saw teeth and a concave base, allowing the conjecture that they are vaguely related to Clovis, perhaps representing some sort of Clovis-Pinto transition.

The closest parallel we have seen comes from Guitarrero Cave in northern Peru (Lynch 1970: 1307 and Fig. 1b). It was found in a level with a human mandible and dated 10,535 ± 290 BP (GX1778).

21) Sharpening Flakes

These flakes are biproducts of reshaping a heavy core tool, which already has been resharpened to a condition in which it cannot be sharpened further without drastic modification. The working edge has become so steep that no more small flakes can be removed cleanly. The biting edge will only step-flake, becoming more and more ragged and obtuse. The only way to correct this is to remove the entire edge with a decisive blow, thus reducing the angle so that a fresh start can be made.

22) Ovate Bifaces

Ovate bifaces are rare on sites in the Lake China basin. Such artifacts are more likely to be found on or near quarry workshops where raw material is abundant. Large bifaces served a number of purposes, judging by our work with quarrying activities in Panamint Valley (Davis, Brott and Weide 1969):

a) they tested the material for quality;
b) they lightened selected pieces for transportation to distant sites;
c) they provided sturdy, all-purpose tools for use at the quarry (wood-working has been suggested as one such task). See Fig. 49d—a biface with a spur beak. We found a similar combination on a bench above Long Valley, Nevada;
d) a large biface could be used as a flake core on the sites; or subdivided into small blanks; or thinned and refined into a preform for a knife or knife/point.

23) Combination Tools

Multi-purpose tools are characteristic of Lake China toolkits of all phases, particularly Late Wisconsin Cultures I and II and Proto-Clovis. Combinations of beaks and saws with such other forms as choppers and spokeshaves are particularly common.

24) Saws, Shredders and Steak Knives

In the future, when this collection is reworked, guidelines should be set up for separating saws and shredders, a distinction of which we were unaware when work with the first array was begun in 1974. The idea of a class of tools for shredding roots and vegetal fibers came from Caroline Osborne (personal communication) who was familiar with shredding appliances, made of shell, from the island of Palau. We suggest that a useful separation of saws, shredders and steak knives can be made on the basis of tooth morphology. Shredders have longer, irregular teeth; saw teeth are shorter, wider at the base and more regular to guard against breakage; and steak knives have very minute and regular serrations. Conforming to these decisions, Fig. 51a should be entitled "shredder" instead of "saw" whereas 51b should be a saw, only.

Steak knives.—The teeth on these specialized little flake cutters are as fine and regular as the teeth of a hacksaw blade. Site no. 1 in the Basalt Ridge locus was evidently a processing/butchering site where steak knives were used in large numbers; 86 were found while mapping Quadrant C, and another 83 were mapped in quadrants A, B and D. The item shown in Fig. 51d is a composite tool with spur beaks, a saw and a triangular broad beak (top).

25) Pounding/Grinding Rocks

PaleoIndians in the Lake China basin made use of cobbles, chunks and slabs of stone for smashing and crushing tasks of many kinds. Occurrence of similar, unspecialized hand and anvil rocks is also widely reported at other Paleo sites (Wheat 1974:28; Hemmings 1970:48, 75, 84, 99–125; Crook and Harris 1958, Fig. 6D). We have found them to be ubiquitous throughout our test area and consider them to be one of the most significant classes of artifacts: they demonstrate that ancestral forms of the miller's art have roots that go back deep in time. Later milling complexes, from Archaic through village agriculture to high cultural levels arose from simple beginnings in the New World Paleolithic.

PaleoIndian pounding/grinding rocks on the Lake China sites have these characteristics:

1) All are made of exotic rock, which had to be carried a long distance to the sites;

2) They were not used with regularized motions like those which evolved later and gave highly developed wear forms to such grinding equipment as Pueblo II handstones and trough metates;

3) They are irregular in shape and suitable for any kind of generalized hammering, crushing, rubbing, grinding and pulverizing;

4) As a group, they show a considerable range of weathering: moderate, heavy and extreme. They cannot, however, be seriated by this criterion because they are made of different materials as shown in Fig. 53, and listed in Table 8.

Fig. 52a-b are specimens from a work area about 100 m east of Mammoth no. 4. Fig. 52a is a flat, irregular cobble handstone, slightly worn by use; whereas b is a pyramidal cobble, somewhat flattened in cross section. It has been worn along both of the narrower sides and is battered into a facet at one end. The material is a fine grained granitic rock, which is exfoliating extensively.

Fig. 53a is an anvil slab from the sides of which a few flakes had once been removed. Both flake scars and working surface have been heavily weathered. The material is a porphyritic andesite. Fig. 53b is a battered and exfoliating quartzite cobble. Both artifacts are from Stake 25.

SUMMARY AND RECOMMENDATIONS

This presentation of tool classes from the various surveys in Lake China basin, is a rough sorting and preliminary typology. Most of the collection has been classed according to function determined by the nature of working members of each specimen, and experimental knowledge of what they can do (ie, puncture, slice, saw, chop, etc.). After being thus sorted, quadrant by quadrant, into the functional classes shown in Table 5, all flakes and artifacts from each quarter (quadrant) of each instrument Stake were counted and tabulated on accounting ledger sheets, providing a base for the tool frequency histograms accompanying each site record in Chapter 5.

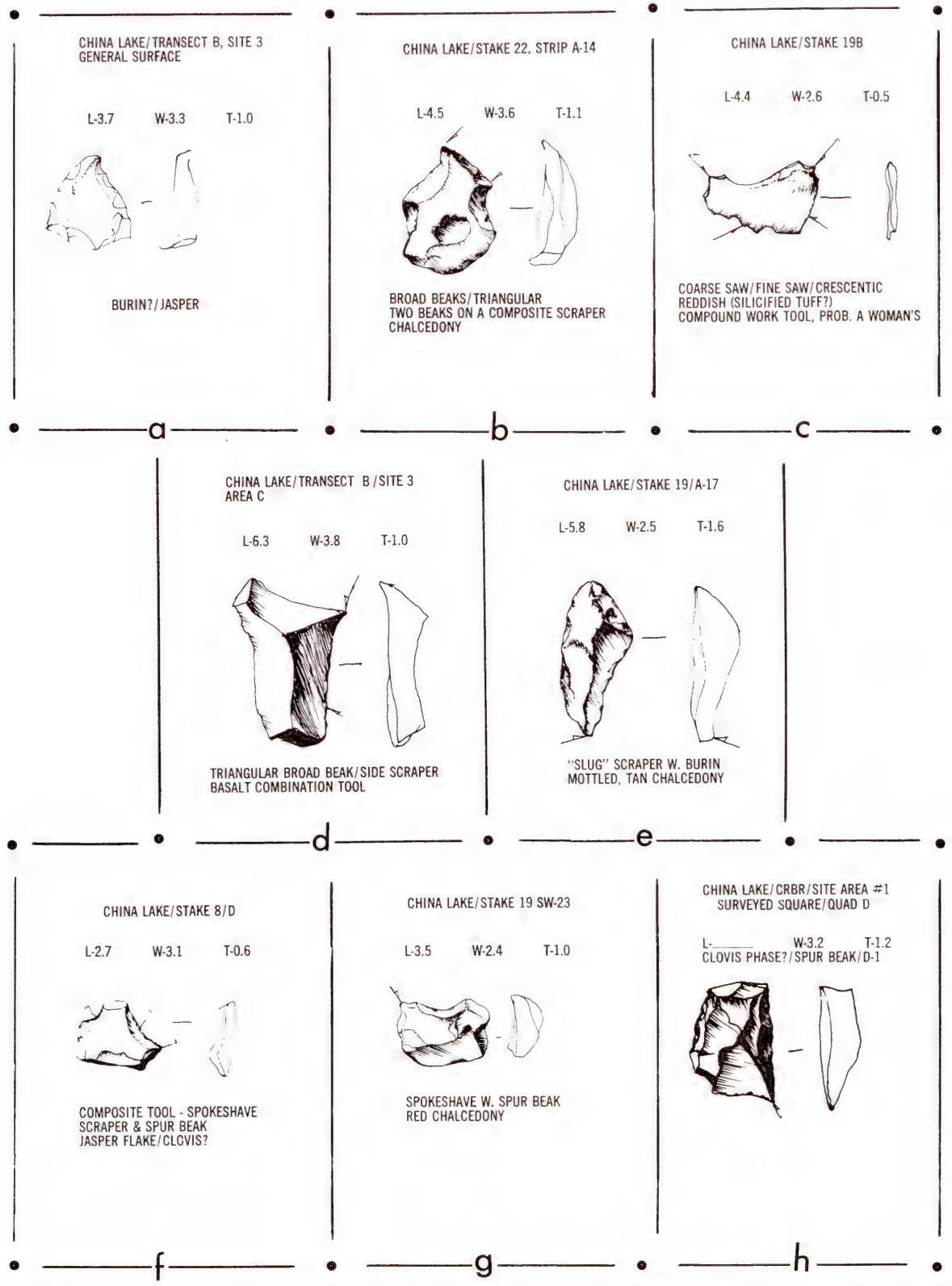


FIGURE 50. *Combination tools*. a) broad beak, curved, with burin tip and 2 scraper edges; b) broad beak, triangular, (2) with 2 spokeshaves and one convex scraper; c) steak knife (fine saw)/coarse saw/spur beak tool; d) side scraper and spur beak, triangular; e) "slug" scraper with 3 kinds of edges and a burin; f) 2 spokeshaves of different radii and a beak; g) crescentic with spokeshave and spur beak; h) double edged side scraper with a beak.

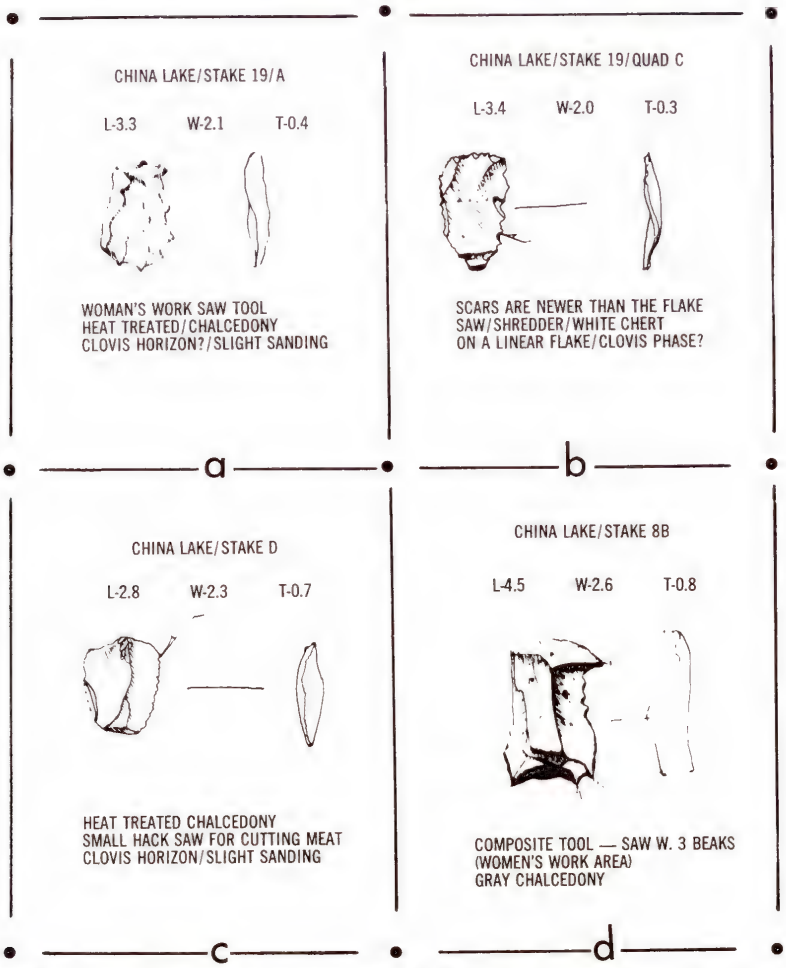


FIGURE 51. *Saws, shredders and steak knives:* a) saw/shredder combination; b) old flake reworked as a saw/shredder combination; c) "steak knife"—a finely denticulated saw probably for butchering and meat slicing; d) saw with 3 spur beaks and broad beak, triangular.

This phase of work with the collections was done very slowly, carefully, introspectively and assumed the magnitude of a complete preoccupation.

During the late weeks of this inspection of Lake China stone, I began to see that degree of physical-chemical weathering varied fairly consistently according to the type of tool and it became apparent that a valid (if highly experimental) chronological seriation of the entire collection could be made using weathering as the guide criterion, followed by technology of manufacture and morphology of the object—the PaleoIndian artisan's cultural and intellectual templates. In this manner, a hypothetical sequence of cultural developments was generated—a model with considerable time depth, allowing for regional changes and new additions from outside. This model is outlined in Table 9, a Long Count Chronology.

A different model is possible—a Short Count chronology: the antagonist of the hypothetical Long Count.

In addition, the following concrete observations and theoretical explanations were noted:

1) all lithic industries were flake industries with the possible exception of a basic Core Tool Tradition, postulated to have been a middle-to-late Wisconsin import from eastern Asia, with a possible time depth of 25,000 to 45,000 years BP in the Lake China basin.

2) The first lithic technologies in the valley are characterized by rough, irregular percussion flaking for shaping and thinning artifacts.

3) Obsidian was not used by the earliest human foragers in this area although it is locally abundant.

4) The first weapons, made of stone, in this valley were cordiforms (wide, thick and heartshaped), and long ovates—thick, rather narrow bipoints.

5) An estimated 13,000 to 15,000 years ago a new flaking technology appeared (we do not as yet know whether it was locally developed or introduced from elsewhere). It is characterized by very wide, shallow,

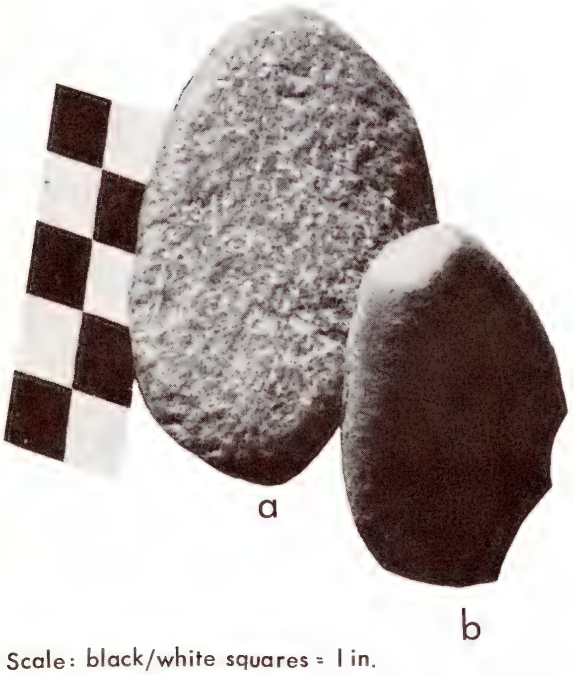


FIGURE 52. *Pounding/grinding rocks:* Both of these handstones are from an area about 100 m east of Mammoth #4. a) an irregular handstone; b) a pyramidal, pestle-like handstone with battered end. The scale shown is 1 inch to a black or white rectangle.

FIGURE 53. *Pounding/grinding rocks* from Stake 25: (a) is a flat anvil slab of porphyritic rock; b) a battered and exfoliating cobble of quartzite.

regular removals of flakes by a hard wood flaker. This striking technique is accompanied by an equally novel form of knife/point: a lanceolate design with a single, faint shoulder, a concave base and remarkably shallow and multiple flutes removed from the proximal end. These are called "long knives" and are proposed to be ancestral to Clovis, Sandia and Lake Mojave—both morphologically and technologically.

6) Basal fluting became rather generally popular and was occasionally transferred to a few Lake Mojave objects which are blends of two knife/point traditions—long ovates and lanceolate, long knives.

7) During all stages, and phases, composite flake tools were common (eg, a spokeshave, sidescraper combination with several beaks; or a crescentic with two spokeshaves and a chisel is another example).

8) With development of a Classic Clovis phase, lithic techniques reached a peak, typified by selection of only the finest silicate rock or obsidian, and heat treatment of the silicates.

9) Crescents of a number of styles are found in all toolkits with the possible exception of the Core Tool Tradition.

10) As an experiment, a portion of the collection has been seriated on the basis of relative weathering: extreme, heavy, moderate, slight and none observable. Because of the constant fluctuations of Lake China, it is postulated (in Table 9) that the older artifacts have been covered with lacustrine or alluvial mantles from once to many times, and then denuded. The longer a tool lay in this situation, the greater its statistical opportunity to be exposed for long periods to ravages of the elements and to attack by the alkaline, caustic environment. Therefore, the older the tool, the greater its probable weathering.

11) The condition and diversity of the stone tools suggests a long period of time for cultural and technical developments, perhaps 45,000 years or more.

12) The presence of (probably) three different cultural/technical entities in the valley also indicates considerable diversity of culture and language, probably by 15,000 years BP.

SOME THEORETICAL CONSIDERATIONS

This project began as a rather blind, unguided search; but it developed a set of practical technologies that enabled us to acquire and bank a large corpus of information—the locality maps, the edge-punched cards and the artifact collections. We also began understanding the whole paleoecological picture of a single area and

changes in this picture over time. The paleoecology is far more inclusive than merely the archaeology of Pleistocene-Recent Lake China. Paleoecology is an overview of environment and biota (including people) as controlled by both climate and irreversible, evolutionary processes.

Therefore, the trend of the project is more and more toward theory. This is essential, since stockpiling information is a dead enterprise unless the work also generates a dynamic philosophy. Since at least two hypothetical models (a Long Count and a Short Count chronology) have been presented, and since these two models are theoretical antagonists, they are a good starting point for a discussion of why such hypotheses are used. What do they accomplish for us?

They are expendable constructs, useful in arranging data, which still lack such essentials as reliable dates (every date we have, so far, may have an error of ± 5,000 years according to a letter from our geologist, George I. Smith). Yet we have clear and massive evidence of cultural diversity and change in the Lake China microcosm. What is the time depth and succession of these changes? The two hypotheses we devised are explanatory games. The Long Count (Table 9) is better because it is based on a single body of real evidence. The Short Count is inadequate for two reasons: a) it cannot contain the anthropological evidence of Lake China alone and certainly is insufficient for the New World as a whole; b) it is based on rather conflicting theories of four other investigators.

RESEMBLANCES BETWEEN LAKE CHINA TOOLS AND OTHER ASSEMBLAGES

Artifacts from the various sites in this basin correspond closely with some North American tool complexes such as the Lake Mojave assemblage [or San Dieguito complex if one chooses to follow Warren (1967)], and going further east beyond the continental divide, Clovis toolkits from Great Plains sites are comparable to Classic Clovis from Lake China. However, there appear to be several inventories in the Lake China deposits which have no recognized counterparts in this continent. These are the (postulated) Core Tool Tradition tools and flake tools. Proto-Clovis knife-points of Lanceolate Tradition and Ovate Tradition are also important lineages. There are a few scrapers and cordiforms—like Jelinek's cordiform knife/point (1966:434)—which have close parallels in Siberia and can be traced back to the upper Mousterian (Rudenko 1961; Müller/Beck 1966).

It is possible that those tools which are tentatively labelled "Late Wisconsin Culture" products have distant relatives among the weathered pebble tools of Sedna Creek (Schlesier 1967:210) and three other sites of the British Mountain complex. A prevalence of broad beaks of triangular pattern and of spur beaks ("gravers") as well as direct percussion manufacture is common to both Lake China and Sedna Creek inventories.

We also note that two cutters, which are a dominant tool form at Lake China, occur in the Sedna Creek group (Schlesier 1967, Fig. 2q-r). Another resemblance is the considerable degree of weathering visible on both sets of artifacts. If Lake China artifacts correspond to any extent with those of the British Mountain complex, then they should also have some traceable resemblances to Siberian inventories from Ust'Kanskaia, the Mal'ta-Buret complex, Sannyi Mys and Chastinskaia.

Siberia was also a source of cordiform knife/points or forms very similar to them. These are illustrated in Müller-Beck's article on American Paleohunters (1966, Fig. 10, nos. 3 and 5) and are from Kostyenki V, Level I. Comparable tools are shown in Rudenko 1961, figures 6, 14a, and 10. Rudenko also illustrates triangular broad beaks and bar-shaped side scrapers (1961, Fig. 15-a, b, c) reminiscent of Lake China specimens. All of Rudenko's tools are from the Ust'/Kanskaia Paleolithic Cave.

ORIGINS OF THE FLUTING CO-TRADITION

Earlier in this chapter, an hypothesis was mentioned briefly: that Proto-Clovis and Clovis traditions originated in the Lakes Country of the Great Basin. Most ancient weapon types had been cordiform and long ovate knife/points of Siberian derivation (see above). Of these two design traditions, long ovate forms persisted, undergoing changes over time. They became wider, thinner, and a single weak shoulder was introduced to facilitate hafting. In this form we have a possible, morphological antecedent of Sandia and Lake Mojave.

This form/function evolution was accompanied by technical changes as well, ushering in the Fluting Co-tradition, which was first recognized at such sites as Dent and Clovis in High Plains regions east of the Continental Divide. However, it may have arrived there in a well-developed stage after spreading from the Lakes Country.

The appearance of the Fluting Co-tradition (in the midst of a possibly older Western Lithic Cotradition outlined by Davis, Brott and Weide 1969) brought with it two technological innovations among Lake China cultures. These departures may have been introduced from the north and are expressed in a) a new knife form and b) a new knapping technique. The knife is very long and thin. It is shaped by unusually wide, shallow and parallel flake removals. This change merits special technological and statistical studies, which should be undertaken later. It is a marked contrast to the irregular percussion flaking characteristic of long ovate and cordiform knife/points.

Long knives, lanceolate in form, usually have one slight shoulder (to prevent the tool from backing into its

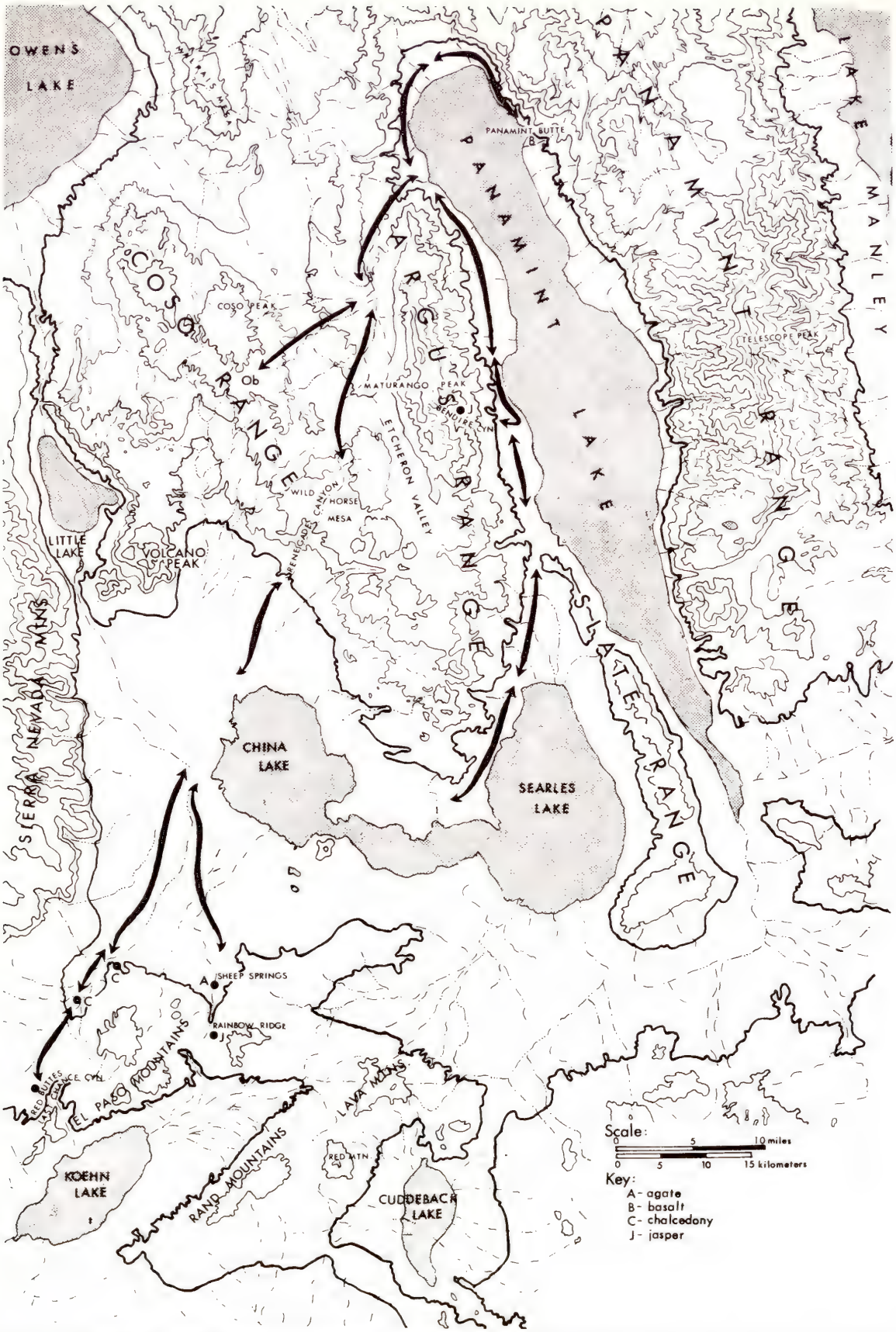


FIGURE 54. Suggested pattern of seasonal transhumance which would have been accompanied by *en route* visits to a number of quarry-workshop areas.

haft when under pressure); and the blade sometimes has a curved edge and a straight edge, clearly shown in Fig. 10c and 29e (the same artifact).

The incipient flutes on all long knives (except d) in Fig. 10 are of particular interest. In all cases they are multiple and are remarkable for their shallowness. Evidently they were originated at a basal nipple (just visible on b and c, Fig. 10) and were dragged off or squeezed off in such a manner as to produce irregular spalls almost as thin as paper. The scars, which are partially obliterated by weathering, have been dotted in with ink. These tracings were made from the artifacts themselves. We have not been able to reproduce these spalls so far, but suggest they may have been fabricated with a punch, or with a hard wood fabricator held at a very acute angle, or by a percussion blow with a great deal of drag—almost like bowing a violin.

Proto-Clovis and Classic Clovis phases are largely hypothetical, as are other time/cultural separations in this study. They are unsubstantiated by excavation, by stratigraphic relationship or by securely associated radiocarbon dates.

Chapter 5
TRANSIENT HOMES OF MIGRATORY FORAGERS: THE SITES

By Emma Lou Davis and Carol Panlaqui

The Shaman

Again the archaeologist walks over to the sandy knoll at Stake 25, climbs to the datum stake and lies down comfortably in the sun. It is a silent, drowsy place. Very drowsy.

Northward across marshes and grasslands are the dark volcanoes and a spine of hills, as clean against the sky as though they had been cut with scissors. Far away on the distant savanna a speck moves and then another. The specks disappear for a time, reappearing closer—they form a ragged line like ants, cross the rise, and gradually resolve as a moving string of people. There are more than 20; people of different sizes, so they must be women, children and men.

Half an hour later, the faster walkers are splashing through a seasonal wash just south of the wide bench, which is their destination, and as they swing up the bank under bulky loads, two young men get up from the sage brush where they had been sleeping 100 paces east. They quickly shake out their fur-string robes, roll and tie them over one shoulder and under the other arm. Then they trot toward the rest of their people. They are the scouts, sent ahead from the Last Chance Canyon jasper quarry a quarter moon ago, to visit a number of possible spring camps and report on their conditions of water and pasture, reed and marsh life. Where are the birds nesting?

The Scouts

These two men are about 19 and 20 years of age and very lean—half whalebone and half rawhide, able to run down any animal (except a wolf) by sheer endurance, never allowing it to feed or rest. Three years ago they had joined with several other young fellows from distantly related bands, and they all ran east as spring began. Without reason. Just to be young, just to be running. Past the great river and on and on through strange country inhabited by giants of red stone who watched them and cast a spell. On and on around badlands, which the giants had painted with every color of sunset. Still on past another broad river with swift currents and treacherous quicksands. Running from dark to dark; resting only briefly, setting snares at night, running down an occasional rabbit or gathering what they could, they travelled until the high plateaus were behind them and they entered a forest. Here they slowed to a walk as the trees grew thicker and then they stopped, awed by the height, the shadow, but most of all by the silence. A deaf wood with no sky.

Standing dead still they could hear the blood pounding in their own ears, when suddenly a stick snapped down the canyon. Then another crack, closer. Seized with nameless terror, the runners turned and fled, scrambling and racing up the divide faster than plainsmen run on the level. They did not pause until the sky became open again on the western slope and they felt themselves to be safe. Then they tumbled on their faces together in a sand pit like a huddle of field mice— perishing of thirst and too exhausted to look for water.

They never go back to the forest. Years later when they are gray and stiff and run no more, they will frighten children around the campfires with stories of shadowy woodlands and an invisible monster who pursues people to drink their warm blood. ''Stay with the lakes, my child—stay with the grassland; spirits of the great animals will support you; the marsh will feed you; the sky is your transparent tent against the Monster.''

Spring Plans

The assorted group of people who are now making themselves at home on the bench, consists of three family bands, related by webs of kinship. As the two scouts join them, camp activities are already starting—dumping loads on the ground, going for water, rummaging in packs for bits of food, and caring for children. Or just lying down to rest. The two scouts make their way toward one of the senior hunters and squat quietly to wait, content to let the camp happenings shape themselves. No one is in a hurry. It is several hours before a handful of experienced elders sift themselves out and begin to discuss plans. Both men and women participate. Men are the hunters, an activity of superior prestige, ex-

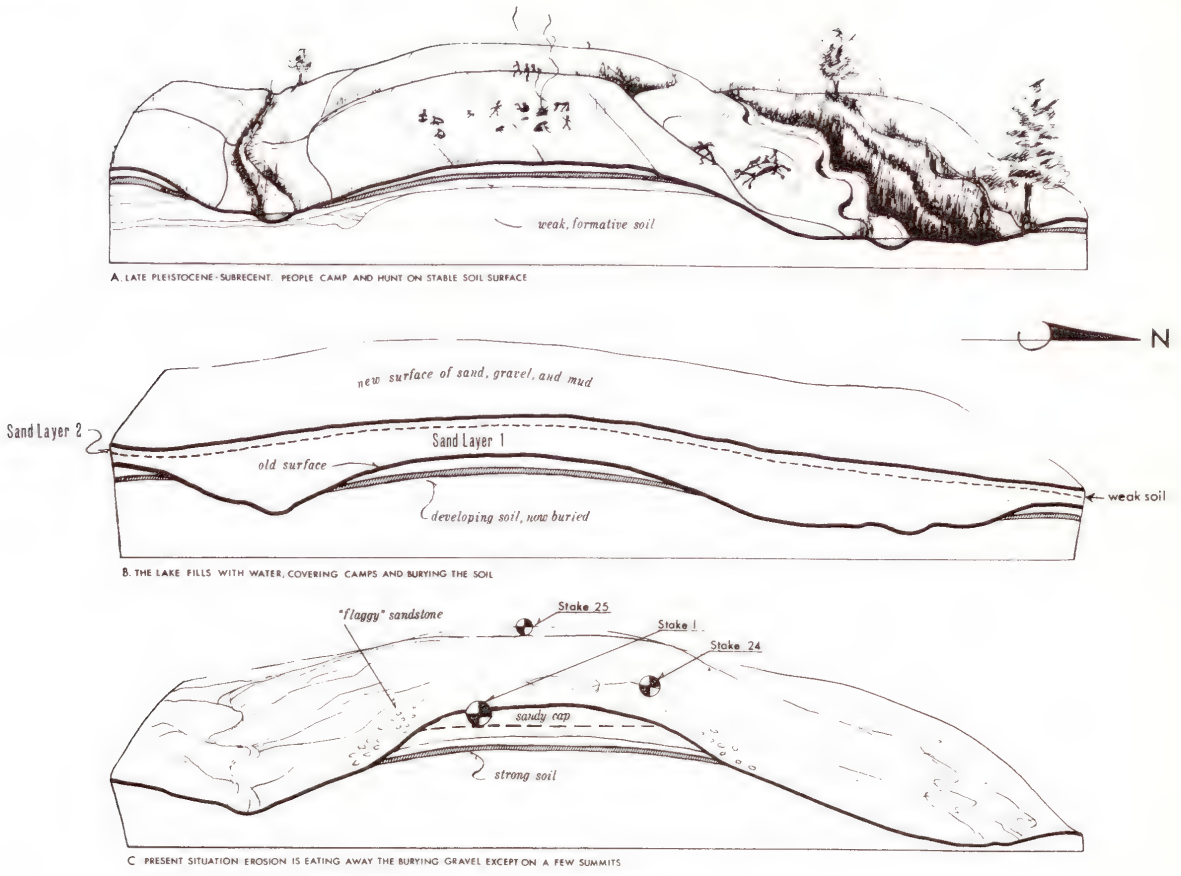

weak, formative soil
A. LATE PLEISTOCENE-SUBRECENT. PEOPLE CAMP AND HUNT ON STABLE SOIL SURFACE
N
new surface of sand, gravel, and mud
Sand Layer 2
Sand Layer 1
old surface
weak soil
developing soil, now buried
B. THE LAKE FILLS WITH WATER, COVERING CAMPS AND BURYING THE SOIL
"flaggy" sandstone
Stake 25
Stake 1
Stake 24
sandy cap
strong soil
C. PRESENT SITUATION: EROSION IS EATING AWAY THE BURYING GRAVEL EXCEPT ON A FEW SUMMITS
STAKE 1 and 24, CHINA LAKE
Block Diagram Showing Changes in Climate and Lake Level

FIGURE 55. a) block diagram showing a late Wisconsin, Paleolithic camp at Stake 1; b) the lake rises, blanketing the camp and landscape. A weak soil has time to form before a second lake transgression mantles it with another layer of gravel. These layers and the soil are sterile; c) recent erosion cuts back through lacustrine gravels and soils, exposing soil remnants, artifacts and animal bone.

citement and (occasionally) a fast bonanza; but 50 to 80% of the daily bread is gathered or snared by women and children. For this part of their living, the marsh is a bountiful larder: birds for the hunter's javelin; fishes and eggs for everyone; rhyzomes, tubers and pollen or muskrats for the women and kids.

Finally, a small conference begins to pick up energy, the scouts are questioned and the sprawling camp quiets as they begin the lengthy, dramatic preamble followed by descriptions of foraging prospects in various parts of the valley. "Where should we camp to live the best? North Bay is no good. The lake is low this year and the Bay is a dry cake, white as a snowfield. Neither are the East Ridges promising places. The lake has retreated so far that the cattails are drying up and there is very bad mud. Until summer rains can restore the water, the best camping and hunting will be along West Boundary where fresh streams feed in from mountain canyons. Out there the gallery forests are greening, the grass is good and we saw both horses and camels."

After a while, the two runners take their leave and join their own families. A few of the more vocal and sociable elders remain squatting or sitting in a circle for a prolonged, enjoyable exchange of opinions. Their voices rise and fall as other members of the group doze, play, work or simply sit around peacefully thinking nothing and doing nothing. They have walked a long way and tomorrow they will walk far again. One of the sleepers is a chunky young woman, curled up on the sunny side of a clump of sage. She gets up with a purposeful manner, unties a little drum and drumstick from the side of her burden basket and walks with them over to the conference circle. Her looks are entirely ordinary except for her expression—brighter, more nervous than the rest.

THE SHAMAN

The young woman is the shaman, Has Claws, so called because during her dark seances the claws of Tall One can be heard scratching on the outside of the hut, sending chills down everyone's spine. A lanky boy gets up and

follows her; this is Scratching Woman, her disciple. He has followed Has Claws since his childhood and considers her to be his mother. He has learned many of her songs and is just beginning to have a few songs of his own. More will come to him later, in dreams or solitude. Meanwhile, he has chosen to be a transvestite.

The change of position of the two shamans sends an electric quiver through the camp, delicately attuned to any unusual goings-on; particularly those bordering on the supernatural. Some people bestir themselves to get a better view whereas others hush their talk and sit quietly alert as Has Claws walks by them. Everyone respects her and it is said that even her husband is a little afraid of her. It was she who dreamed the great ground figure in Panamint Valley, naming it Star Trap. At sunset of the day when they all finished this configuration, she and Scratching Woman placed offerings under a row of cairns along the north side of the lines of stones and the shamans danced until dark, accompanied by incessant beating of the drum and a repetitive calling song, inviting each star in turn to come into its own place in its new home. Campfires were built up and everyone feasted on nuts and meat and the last of the dried berries from summer, and then they circle-danced hour after hour until a gibbous moon rose over fresh snows on the peak. When the moon was free, no longer catching her chin in the distant pines, Has Claws walked forward, naked to the waist in the chill and commenced to drum and sing once more while the dancers sat down.

Then everyone saw that the stars, indeed, came down and sat—each star—on the edge of a stone while the woman, drumming, began to grow tall, looming the way mountains in a mirage loom on icy mornings. Her body became more and more attenuated, rising into the night sky so that only her feet remained standing and her voice drew further and further away. Drumming filled the whole night.

Everyone perceived these things, even the small children, who burrowed under their parents' arms and legs.

Much later as the sun began to redden little clouds over the peak, people awoke feeling marvelously refreshed—all except the two shamans who lay in a deep trance, looking at the sky with open eyes.

Therefore, as the woman and boy now walk across camp, everybody becomes charged with anticipation. The pair sits down outside the council circle, remaining quiet as stumps until the last speaker has stopped. Then Has Claws drags her drumstick lightly across her drum, striking it once. The debaters turn toward her and Scratching Woman shifts position so that the circle melts and reforms, incorporating shaman and apprentice as a new center. She stands and begins drumming a catchy beat while the boy dances to and fro with unexpected changes of pace. This syncopation and change rivet attention while the dancer bounds back and forth, first to the north, then east, then south and west, where he stops.

She intones "my Familiar came to me while I slept. He came as Bison, shaking his wide horns and telling me 'there are animals along the mountain foot, west, where the streams grow smaller, spreading into little marshes. Go call the animals.' I cannot call them here. The Spirits do not like the light and all these eyes, so we will go over the bank and near the water." She picks up a cobble from the ground and kneads it firmly between her hands, then relaxes her fingers and a shower of round pebbles falls to earth. "There will be many animals like the many pebbles" and the shamans walk toward the bank, dropping out of sight.

The rest of the camp resumes more ordinary activities—reparing gear, taking off in search of food. Some of the men start eastward to stake a net across a creek for a bird hunt. A work party of women and older children go north to a cattail swamp to collect fresh shoots, rhyzomes, eggs and perhaps a few fledglings and rats. The sun moves west past the meridian. Those who remain in camp see a curl of smoke drift over the distant bank, and they smell the incense of juniper. Then a steady drumming begins and all campers sit down to focus on the juniper smoke, waiting for whatever happens. You never know.

The shaman wails a high, sustained note ending in duck quacks, changing abruptly to an invocation in a growl, calling to ducks. Her apprentice answers with an unearthly cry, echoing from everywhere. The stanza is repeated for goose, followed by the apprentice's eerie quaver and so they continue until all birds and animals have been called. The drumming reaches a crescendo, then slowly becomes irregular, dimmer, further, and everyone knows the shamans have changed form and are dancing with the animals.

Just as sunset is darkening to a line of orange, people have eaten and are beginning to lie close to one another under fur robes, their feet toward the fires. A twig crackles and the little flames say "whit, whit."

The shamans appear out of the dark and walk straight to a senior hunter of their own band. "There is a peak. There is a sharp peak straight west. Go toward it until we find a stream and a little bog. A few horses and camels have moved in there to feed on the watercress. It will be easy to trap some in the mud."[5]

SITES AND STAKES

Studies of our maps and histograms; artifacts and flakes, suggest that a number of different kinds of sites are represented in the survey area as follows:

[5]Their destination is a place we know as the Henry Site. Otherwise, this establishing shot is put together from many ethnographic sources and observations. Some of the passages on Paleo-Siberian shamanism are lifted out of Bogoras (1903–1904:413). The huge ground figure to which the imaginary name "Star Trap" has been given is referenced in Davis and Winslow 1965 (Fig. 2 and 4); also in Rogers 1966: 18 (photograph).

A) Large mammal kills (along shorelines at stakes 1, 22, 24, 25, 27; Basalt Ridge Site 1.)
B) Home camps of small, family bands of 8 to 25 people (stakes 25, 25NW, 19SW, 8NE.)
C) Hunting large waterfowl (Stakes 13, 19).
D) Marsh foraging (Transect B, Site 3).
E) Primary butchering (dismembering a fallen animal into portable chunks)—Basalt Ridge Site 1; Mammoth no. 4 (?)
F) Secondary butchering (boning out meat; processing for consumption or preservation—the Henry Site; Basalt Ridge Site 1, shore; Stake 27; Mammoth nos. 1, 2, 6, 7.
G) Utility processing (preparing plant and animal products for manufacture; work with reeds, fiber, wood, hide, bone and fur)—Stake 8A, women's work area; stakes 7, 8, 9, 25NW, 19SW.

Seasonality of Use

Clues to seasonal use of the sites have been extracted by calculating relative proportions of obsidian and silicates in the various flake counts. These proportions tell us which direction the foragers took between their old camp and a new one on the shores of Lake China. Sources of obsidian were northward in the Cosos, chalcedony was south and jaspers were to be found in more scattered distributions as shown in Figs. 22 and 54. The black arrows in Fig. 54 point to avenues of seasonal migration.

Obsidian was brought into the basin from Wild Horse Mesa to the north; Bendire Canyon jasper came from northeast as did Panamint Butte basalts (Weide 1969: 79); Milspaugh Canyon jasper, crude in quality, could be collected while crossing the Argus Range between Owens, China and Panamint Valleys. Southward from Lake China were sources of high quality jasper, agate and chalcedony at Sheep Springs, Rainbow Ridge, Last Chance Canyon and around the El Paso Mountains.

Although there has, as yet, been no problem-oriented research to locate the outer margins of PaleoIndian land use, a practice of seasonal transhumance is one of the basic hypotheses of this report. The plants were seasonal. The animals were doubtless seasonal (like deer populations today), and, therefore, wide ranging would have greatly expanded the natural resources available to small bands of exploiting foragers. A range from the Sierra crest, across Lake China Basin and climbing again to the Argus Range spine, offered a variety of biotic communities, water, and bad-weather refuges for shelter.

We suspect that an American male nostalgia for the romance of hunting has effectively masked the real versatility of PaleoIndian hunter-gatherers, their command of their environments and ingenuity in coping with these challenges both socially and technically. Seasonal transhumance was merely one of many social/ecological adaptations, possibly with roots that go deep into the Middle Paleolithic of Asia. It is likely that the Marsh and Grassland Paleo peoples went south or east into lower country (such as Death Valley, Superior and Koehn Valleys) during the colder months but returned in spring to the abundant life of Lake China, the north basin of Lake Panamint and the southern end of Lake Searles.

Late summers might have been spent considerably higher in the mountains, particularly in seasons when pine nuts and berries were plentiful. As an example, Lake Mojave knife/points occasionally are found in mountain localities, negating a hypothesis that was formulated 12 years ago (Davis 1963) suggesting that the high country was too chilly to be inviting to Paleo-Indians. They may not have stayed there long, but they were obliged to go to the El Pasos and Cosos to visit quarry-workshop sources of stone for their tools. The mountains also had upland meadows, which probably were summer ranges for migratory animals.

Relation of Sites to the Lake

The lowest point in the valley is at its southeastern corner, near the more recent of the two Pleistocene outlets into Lake Searles. At present this sump is occupied by a shrunken and saline lake remnant. The remainder of the valley as far as the Sierra alluvials is a place of very low relief: there are numerous sand-covered, residual land forms rising only 2–3 m above the basin floor and this floor has a westward trending rise of only about 1.5 m in 2 km of distance. Therefore, each meter of rise in water level of the lake would flood a surprising area of grassland, turning it first into cattail swamps and then into deepening expanses of water. This water in turn blanketed the drowned landscape with a layer of mud and gravel (see Figs. 4; 55). This mantle was draped over older landforms and accounts for the sand-covered knolls, which have provided us with slightly elevated instrument stations for our mapping program. Absolute elevations of these stations are shown in Table 12, which should be used as a reference with the site descriptions which follow.

Our observation has been that all sites (with a possible exception of the Henry Site) were related to various stands of a shallow lake; the lake filled or receded to different levels, repeatedly and rapidly so that there is scarcely a place in the valley that has not been a shoreline at some time. Nodal points in these oscillations are shown by high water peaks and low water soil formations in Table 11.

Primary Marsh Dependency

We believe that marshes were the primary ecological focus for countless generations of PaleoIndians in the

TABLE 11

Comparison of pluvial conditions of five Western lakes

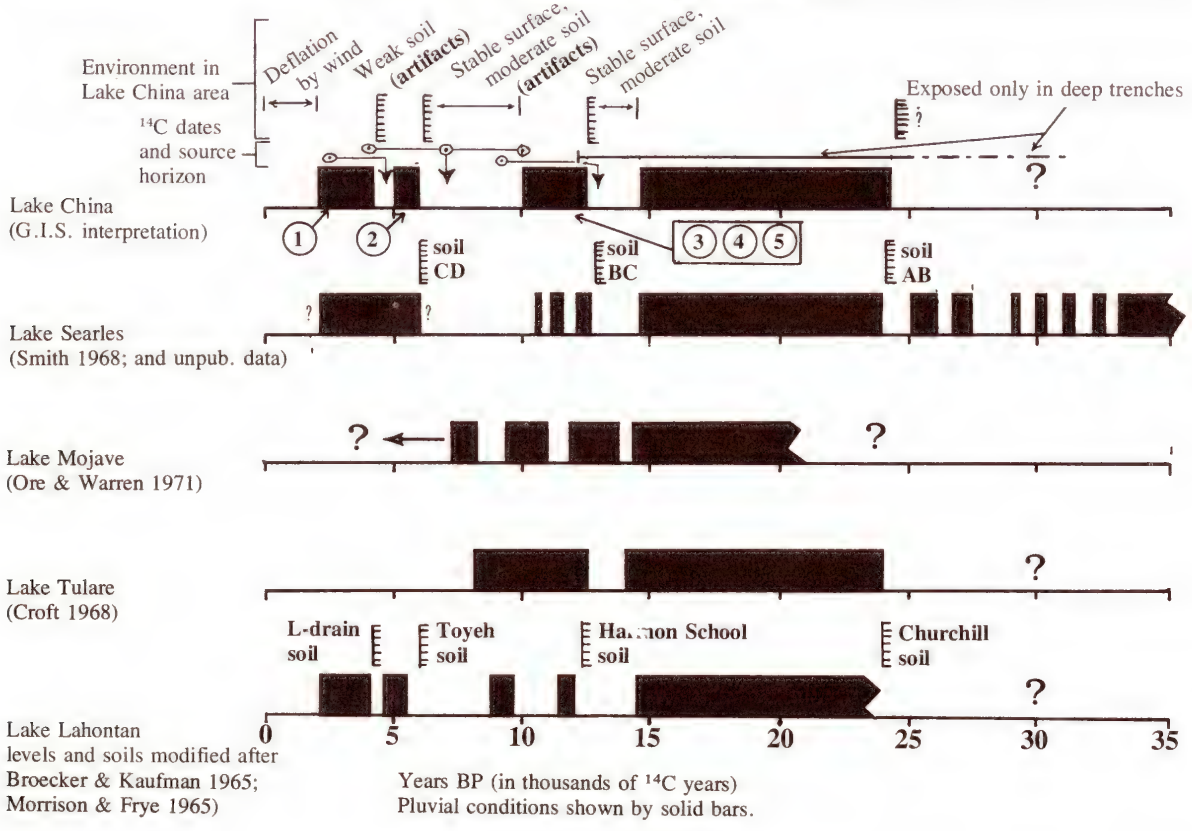


TABLE 12

Elevations of instrument stations at various stakes. Measurements in feet from mean sea level.

Station	Elevation	Station	Elevation
Tower 5	2181	Stake 8	2178
Playa S of 8	2160	Stake 19#	2178
Stake 8 NE	2164	Stake 19 SW	2182
Stake 7	2170	Stake 9	2183
Stake 13	2171	Stake 24	2184
Mammoth no. 1	2171	Stake 2	2186
Stake 26	2173	Stake 1	2186
Stake 11	2173	Stake 25	2191
Stake 22	2177	Basalt Ridge' (top of basalt)	2234
Stake 10	2178	Henry Site	2259

Lakes Country. Marshes are eutrophic, naturally rich ecosystems (Odom 1900:122, Fig. 7-3A, B and C). Early peoples who used the changing valley of Lake China evidently had two subsistence foci—the grasslands and the lake, particularly its sloughs and swamps. This conclusion is based entirely on observations of repeated connections of geological and cultural phenomena: land summits; water margins and artifact concentrations. We, therefore, differ slightly from previous writers about what the Great Basin paleo cultures should be named.

Rogers (1939:27) emphasized a fossil lake relationship applying the term "Playa industries" to certain cultural remnants. Warren (1967), Hester (1973) and Tuohy (1974) follow suit, the latter two classing all middle PaleoIndian cultures under a rubric of "Western Pluvial Lakes Tradition," again emphasizing an archaeologist's preoccupation with dry playas and a previous, Indian preoccupation with lakes. In our opinion we can now be more specific about early human adaptations, which were far from being unifocal. Lakes Country people used the upland plateaus and canyons, the valley grasslands and, most of all, the marshes that served both as supermarkets and as animal traps for large herbivores (who had to be partially immobilized in mud before they could be approached for a kill).

Therefore, while pursuing these studies, we have come to think of these PaleoIndians, in this part of the Americas, as Marsh/Grassland People. Of the two foci, marshes were primary.

Many people, over a long time evolved these adaptations to both biogeographical provinces. The folk who subsisted in this varied countryside were wily foragers,

commanding a number of highly developed skills as beaters, trackers, botanists, hunters, herbalists, builders of snares, collectors, weavers, artisans and butchers, and last but not least, cooks. Primary marsh dependency seems to have persisted until the onset of an interstadial, which we call the Holocene, causing extinction of much of the marsh and grassland habitat. This extinction in turn was, probably, a major factor in faunal extinction of some of the savanna dependent herbivores. Repercussions upon human foragers are reflected in a scarcity of Archaic artifacts in the basin of Lake China. After this lake shrank to a saline puddle the Indians betook themselves elsewhere, and ancestral forms of the Desert Culture (Jennings and Norbeck 1955; Warren 1967:168) became increasingly specialized.

Relation of Human Occupancy to Soil Formation

A discovery made possible by this program, is the existence, correlations and approximate dates of three soils at Stake 1. Soils represent stable conditions of undisturbed weathering and, therefore, were associated with periods favorable to human activities in the savanna/swamp/lake environment of the valley. Soils formed during periods of partial to extreme lake recession in the related basins of Lake Searles and Lake China (see Table 11). Both localities have a series of radiocarbon dates, but those at Lake Searles are more reliable and can be used as guidelines for Lake China. It should also be possible to make cautious extrapolations to soils in the valleys of Lake Panamint and Lake Manley (Death Valley). Particularly in the Lake China basin soils I, II (with artifacts), III (possibly with artifacts), as well as deeper paleosols as yet undiscovered should guide our next program of work.

Paleosols Point to Times and Places Suitable for Human Use

A soil is a product of weathering of a stable surface—an exposed area of ground that is neither being buried by alluvium nor eroded by action of wind and water. Surfaces of this sort are protected from flooding, probably stabilized by vegetation, and are generally good for camping provided they are close to subsistence sources. In the cases of those localities we have designated Stake 1 and Basalt Ridge, China Lake soils I and II (shown in Table 11) were in close association with marsh and grassland ecotones. People lived on dry land but were comfortably close to the "grocery store"—a marsh. Stone tools were used and abandoned in camp or around the margins of water where various kinds of work were done, but were less likely to be dropped in the gumbo while still in use.

Comparable associations of artifacts and soils occurred on east African sites of Middle Paleolithic Age (Wendorf and Hester 1975, Fig. 2). Artifacts were deposited in four strong soil units just as they have been found upon or within China Lake Soil II. When this report is finished and field work is resumed in the region of Lakes China, Searles and Panamint, much of our energies should be devoted to uncovering segments of older paleosols and searching for living floors. In this work, our site area maps will be our best guides. Soil II at stake 1 evidently has traces of habitation; horizontal extensions of Soil III or its remnants should be investigated for signs of artifactual stone. *If we can find such clues, they will verify the hypothesis of cultural activity greater than 14,000 years of age in this locality.*

This archaeological work should, in turn, bring in more information about episodes of drying and submergence. We also may learn more about the etiology and extent of carbonate contamination, which seems a major stumbling block in our chronology. As an example, most of our radiocarbon dates may have errors of as much as ± 5,000 years. In Table 11, a ^{14}C date of 9,350 years BP is shown in possible association with soil III. Yet we are fairly sure, from correlations with Lake Searles, that this particular soil was being formed between 14,000 and 16,000 years ago (George I. Smith, personal communication). Inspection of Table 11 makes clear the amount of work remaining to be done to fit together the water oscillations of three lakes and to understand the constant changes that controlled PaleoIndian relations with their unpredictable landscape.

PaleoIndian Land Use

While Lake China and the climate wobbled through their cycles, people lived on change and adapted to abundance and scarcity alike, changing their ranges with opportunistic ingenuity. At all times they had to make five major subsistence choices: choice of a camp site; and of a gathering site; choice of a natural trap or kill site; a butchering site; and a processing site. All of these are represented in the roster of mapped localities which follows.

Choice of a campsite.—PaleoIndians like the rest of us chose to camp on a piece of flat, well-drained ground with at least three additional advantages: water within a short walking distance; a clear view of surrounding territory (Judge 1973:125); situated preferably on the lee side of a natural water trap. In addition, proximity to natural foods and to raw materials for soft-goods manufacture were of great importance. The additional verdure along edges of marshes doubtlessly was a major attraction for large herbivores as well. These margins appear on our plane table maps to have been the real scenes of action: animals went there to feed and drink; people

frightened them into mud and killed them and camps were then set up on higher ground while meat processing and many other kinds of work took place along the beaches.

The maps of stakes 1/24 locality and of Basalt Ridge Site 1 indicate concentrations of large animal bones in linear or arcuate configurations, which appear to follow shorelines.

Choice of a killsite.—Large animal hunting tactics of these people were evidently to drive the creatures or surprise them when watering and panic them into a boggy spot where they could be dispatched while partially disabled. Basalt Ridge sites 1 and 2 are good examples of an ideal killsite, which must have been used many times. In this locality, a high basalt outcrop provided lookouts with a hiding place or a blind, commanding views both of wide grasslands to the southwest and a small, shallow bay to the north.

Killsites in streams or swamps are also a boon for the paleontologist, since much of the bone could not be recovered. Left in the mud, it quickly became invested with a coat of carbonaceous ooze that protected it against the elements and predators, and accelerated mineralization. There it still lies, slowly weathering out.

Choice of a butchering place.—In the case of small animals, there was no problem. Small game probably was snared, or trapped; smoked out or hooked from its nest and carried back to camp where it could be prepared in a number of tasty ways. Frank Hamilton Cushing's Zuni "rat-brine" is one in which the dead wood-rat is tossed, whole, onto coals, toasted crisp and then pounded up, guts and all between two stones (Cushing 1920: 599). Due to the rat's preference for piñon nuts, the entrails impart a spicy flavor during this marinaded-on-the-hoof cookery. Michelson (1967:73) has a similar recipe for Savory Rat as made by the Paipai, in which the roasted animal is eviscerated (perhaps an American refinement), the legs removed and nibbled like fried chicken whereas the remainder of the carcass including the bones is pounded to a pulp on a metate. (PaleoIndians would use pounding/grinding rocks).

Large creatures had to be dismembered in place and the pieces transported to higher ground if possible. Therefore, a proper combination of water, mud and dry land had to be sought as the terminus of a hunt. Different amounts of bone found in various localities indicate a high degree of selectivity in planning kills and butchering operations together. Butchering places were wrecking yards where big herbivores were systematically dismantled and component parts were prepared for immediate eating, storage, or utility (hides, bones and sinew).

Men probably did the heavier work of disarticulation (using choppers and pounding/grinding rocks), boned out or stripped the larger muscle masses into blankets of meat and entrails. Meat processing seems to have consisted largely of the preparation of jerky and might have been the task of women and children using sharp flakes, hafted cutters and "steak knives." This work took place slightly higher up the shore where brush could be laid out and racks constructed.

Hunting Large Waterfowl

Snares, nets and decoys might have been used for birds but there is no archaeological record of them. Bunts, however, are common in the collections and probably were connected with this phase of hunting. In addition, crescents, which have already been discussed in Chapter 4, probably were associated with a special method of taking large birds while they cruised on the water. Ducks, swans, geese and brant could be disabled, with a broken wing, if struck at water level by a hard blow from a crescent mounted in a heavy staff. It has been suggested that the butterfly wings of such crescents were installed pointing backwards so that the missile would skip if it glanced on the water before hitting the prey.

A technique of this sort would imply stretches of open water where hunters could get a clear shot. Since some of these waterfowl are extremely wary (geese, when feeding on land, post sentinels), it is assumed that people camped at a distance from the hunting areas.

Marsh Foraging

Acre for acre, marsh areas probably produced more foods and utility materials than any other ecosystem in the countryside: young cattail shoots in spring, pollen, rhyzomes, tubers, frogs, fishes, muskrats, nestling birds, eggs, and materials for mats, baskets and cordage—supplied by willows, Indian Hemp and grasses or rushes. Transect B, Site 3 was evidently a locality that was used for such purposes periodically during very low stands of the lake (the water must have stood at levels less than 2,160 feet MSL).

Only a single crescent was found on the entire length of Site 3 (about 300 m). If our hypotheses are correct, this scarcity of crescents indicates that open water was not present near this site locality. It is probably a place where people were collecting and processing materials from an environment of marsh and reeds and were subsisting on the marsh foods enumerated above. There is no large animal bone at this shore and only two bone fragments from a rather small animal were collected. In summary, the sites were situated on a sand spit between two seasonal washes and this spit or bar protruded into a reedy area of shallow water and mud. It is a good example of primary marsh dependency.

UTILITY PROCESSING

Many kinds of work was done in these camps, *perhaps with a slow shift, over time, to greater and greater emphasis on orientation toward big animals,* while retaining all the earlier subsistence and manufacturing skills. These peoples were versatile artisans who used many substances to create useful or decorative objects, judging by their toolkits.

As the millennia passed, both tool forms and techniques of tool production changed. Refinements of detailing became increasingly specialized. After handling thousands of Lake China stone tools, we see a progression from simple toolkits of rugged core and flake implements with Siberian counterparts, through better control of percussion flaking followed by development of pressure flaking methods.

Early use of basketry and lightweight construction of wooden frames are indicated by very tiny spokeshaves with deep notches. These were illustrated in Chapter 4 (Fig. 37a-c). The foragers also made clothing, personal gear, hunting equipment, snares, footcovers for long treks, ornaments, shelters, and devices for coping with fires and cooking. It is unfortunate that extreme weathering of most of the stone tools has obliterated marks of use wear.

THE SITES

STRATIGRAPHY OF THE SITES

Stratigraphies were produced by episodes of the lake. Prior to 11,000 years BP the lake rose, flooded and broke up an earlier soil (possibly representing a stable period between 14,000 and 16,000 years BP). This proposition is based upon a written communication (1975) from the Project geologist, George I. Smith. Pieces of the soil then became incorporated in a hard, cemented layer of lacustrine gravel, which also contains artifacts. Between 10,500 and 7,000 years BP another stable period allowed a soil to form again. People camped on this surface and left artifacts that are found both *in situ* under sands above and also weathering out around the margins of these residual sand patches where erosion is attacking them. Subsequently, the lake rose twice more. It covered the whole landscape with a mantle of coarse sand, which lay exposed long enough for a weak soil to form at about 2,500 years BP. This soil is sterile. It was covered by a final lake transgression with another blanket of coarse sand, slightly different in color from the first.

These events are outlined in Table 11. This particular sequence is based on excavations and dates at Stake 1, trench 3. However, the general superpositions of this series will doubtlessly be encountered at other sites as our work continues.

THE SITE MAPS, HOW TO READ THEM

The "sites" are visible as non-random, localized artifact concentrations within the survey areas or stakes.

1) Each stake consists of a base map or background. This is scaled along two margins like a city map: (lettered along one border and numbered along the other). These subdivide each stake into 305 m squares.

2) There are several drawings accompanying each stake description. The drawings break down information into comprehensive bits and prevent excessive clutter. They are for clarity.

3) First, a background map of the topography of that particular stake has been prepared and the bone on the surface has been added.

4) Second, the total scatter of the artifacts and flakes is added.

5) Third, a print of the background with bone *only* is used several times as needed to show special distributions of such diagnostic artifacts as fluted knife/points; "Lake Mojave Points"; crescents and gravers. *This system has a grave deficiency*—we have observed so many novel objects and learned so much in the past years, that our original classifications have been greatly revised and refined. Therefore, these diagnostic maps indicate extremely crudely-defined taxa.

6) Last of all, the entire corpus of artifacts was sorted and classified site by site and a count was taken of the numbers of each artifact category in each quadrant of the stake. This completed the information necessary to build a histogram of artifact numbers accompanying each sequence of drawings. This format has been followed for every area where possible.

THE HENRY SITE (FIG. 56A-C)

Elevation of datum.—2,259 feet MSL.

Situation.—On the bank of a stream, slough or bay.

Surface Deposits.—Dense clay near rim of bank overlain by sand and coarse gravel. Near the power line (Fig. 56a-b) there is a low mound covered with clinkers of a "flaggy sandstone" composed of carbonaceous clay pods and cemented gravel from a paleosol. This soil remnant should be further investigated and dated if possible.

Fauna.—*Camelops* sp. and unidentified bone appears to lie in non-random distributions.

Cultural activities.—Short-term, single occupancy camping; meat processing. Two ovoid patterns suggest outlines of shelters or huts..

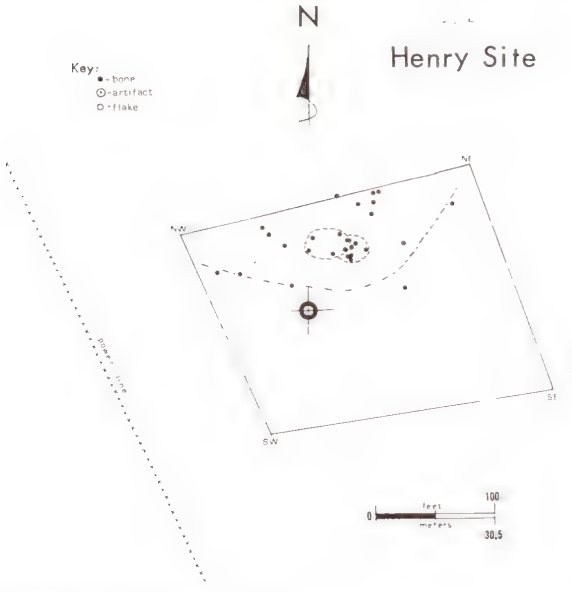


FIGURE 56A. The Henry Site, background and bone.

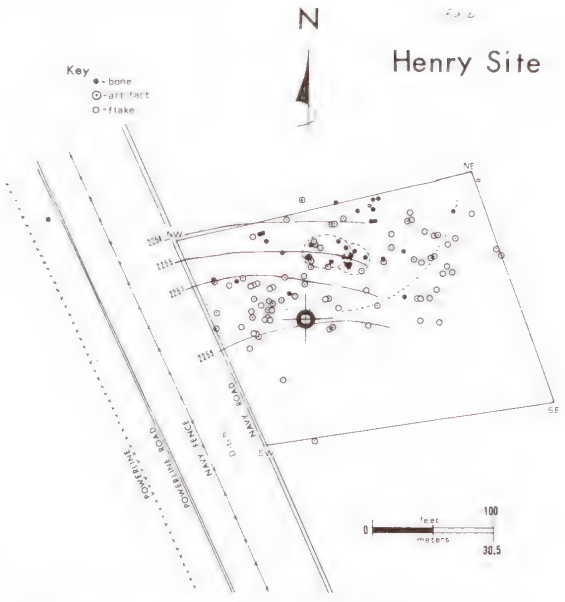


FIGURE 56B. The Henry Site, contour lines and artifacts.

Paleocultural affiliation.—Lake Mojave Complex?

Artifacts.—There was only a single styled artifact found on this site—a stemmed knife/point suggesting an affiliation with Lake Mojave. The "Lake Mojave" artifact appears to be late PaleoIndian and is poorly defined. The remainder of the Henry Site toolkit is a good example of the importance of slightly modified flakes in Lake China toolkits.

There are 47 classifiable flake implements, of which 27.6% are cutters, adapted to fine slicing. The presence of these little scalpels in association with animal bones implies meat cutting or processing as a major activity. A number of observations were made about these tools:

a) A few have faint scratches on their flat surfaces. The scratches go in different directions and look like results of free-hand whittling.

b) Some of the flakes also show patches of a tan incrustation, which is hard like a tufa. This should be examined microscopically and dated, if possible.

c) Some are considerably less sanded than others, although manufacturing techniques are the same. This raises a question about the validity of physical abrasion as a criterion of age, since, at this site, people may have camped and left their stone traces only once. Therefore, differential sanding of volcanic glass objects can only be explained by the accident of some artifacts enduring exposure longer than others.

d) A trace element analysis of the obsidians should be made to determine their sources. Hydration measurements should also be made.

e) There are no blades.

f) A number of flakes are sidestruck.

g) Almost without exception, the acute edges of these flake tools show use-nicks. A microstudy of the

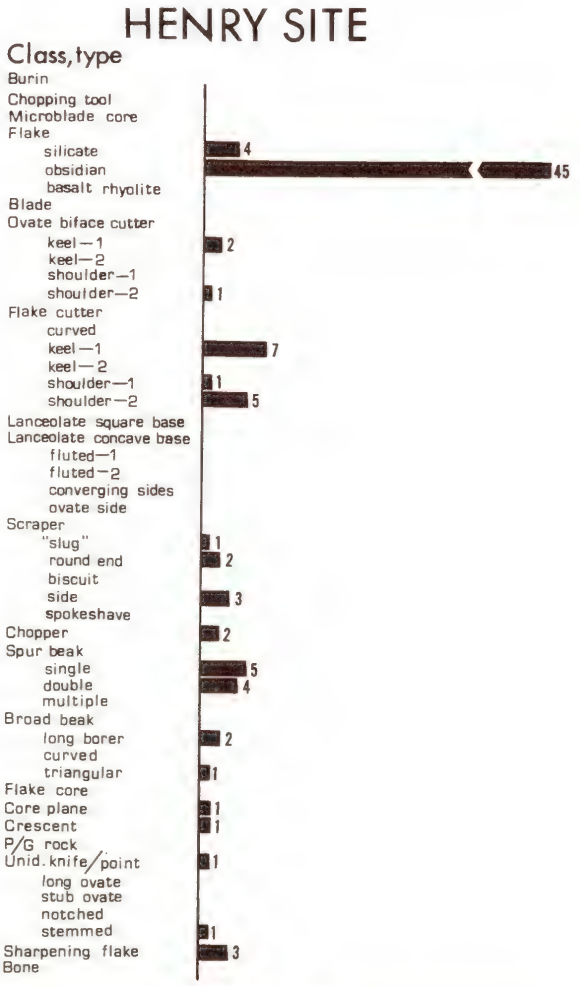


FIGURE 56C. The Henry Site, artifact quantity histograms.

nicks should be made, looking for telltale signs of second generation nicking—an indication of multiple visits to the locality over time.

h) A few specimens appear to have intentional microserrations, converting them into ''steak knives'' (see Chapter 4).

i) Cylinder hammer percussion appears to have been the method of production of this deceptively simple toolkit.

Discussion.—Three illustrations accompany this brief of the Henry Site. Fig. 56A indicates distributions of bone; 56B has artifacts and contour lines added, whereas 56C is a histogram of flake and artifact numbers.

The Henry Site is one of the most significant cultural localities in the valley. Small and isolated, it appears to have been an archaeological unit, a single component camp. We believe that it was used by people who came into the valley from the north (see Fig. 54), judging by the preponderance of obsidian (Fig. 56C). Some of the ''glass'' resembles gem quality material from Truman Meadows, a source area near Montgomery Pass on the California-Nevada border. Therefore, obsidian from the site should be analyzed for trace elements, its sources identified and obsidian hydration measurements taken.

The Henry Site is one of the best examples we have of association between people and an extinct fauna. Non-random distributions of bone and two ovoid configurations imply human activities and possibly the existence of some kind of shelters—either windbreaks or huts. When we return to the field, this site should be tested and excavated as indicated to discover its stratigraphic sequences and their relation to fossil water and to paleosols.

SITE AREA T 25 S; R 40 E,-28

Elevation of datum.—(at Mammoth no. 1) 2,171 feet MSL.

Situation.—Variable terrain. This general surface area includes all of Section 28 on the Ridgecrest Quadrangle sheet. This is a landscape of very low relief with faint ridges and drainage patterns. The ridges are in the vicinity of stakes 1, 24, 22 and just southeast of Mammoth no. 1 at Stake 11. Beside the Mammoth locus there is a discernible E-W wash connecting this site with Mammoth no. 4 (Fig. 57). The wash runs westward through a shallow trough between stakes 24 and 19, disappearing in the direction of Stake 25 NW.

FIGURE 57. Fortsch begins excavation of Mammoth #4. Only portions of the left side of the animal remained, having been protected by burial in mud. The skull was destroyed but a 2 m long segment of the left tusk was recovered.

Surface deposits.—The top is covered with a coarse, reddish gravel, of unknown age (an enormous amount of work still remains to be done to identify, date and correlate the complicated stratigraphies in this valley). Also, there are some remnants of the cemented clinkers or "flaggy sandstone" that are diagnostic of an eroded paleosol (probably equivalent to the 15,000 BP year old soil at Lake Searles [Smith 1968, Fig. 5]).

Fauna.—Mammoth no. 1 was in immediate association with a chert chopper (Figs. 58 and 59, upper) and less close association with two very weathered, jasper flakes (Fig. 59, lower). Mammoth no. 2 and a camel jaw were in proximity to a chalcedony chopper fragment and an obsidian knife.

Cultural activities.—Within the large area of Section 28 (1 Statute Mile square) a number of fossil microenvironments are represented, each of which was suitable for different activities. Mammoth nos. 1 and 2 are probably remains of kill and butchering work. Hunts, drives and stalks probably were confined to more distant grasslands, but the marshes were used as natural traps for big animals that were either driven there or stampeded while drinking. Birding and foraging were activities of the marshes, streams and shallows. Processing of large animals took place along the nearest shore whereas manufacture of portable objects was largely done in camp. These camps were on dry, slightly higher terrain, of which stakes 1, 22 and 25 are good examples. Test excavations have already been made at Stake 1 and we know that there are artifacts buried under the sand and resting on or in the strong paleosol, which dates somewhere between 11,000 and 7,000 years BP. Similar excavations should be made at stakes 22, 25, 8 NE and the Basalt Ridge.

Paleocultural affiliation.—These are still uncertain but probably represent a long sequence from the Core Tool Tradition, through Late Wisconsin Cultures to Clovis and Lake Mojave. Evidently, small bands of people came into this valley over a long period of time and from several directions.

Artifacts.—This part of the collection was made while we were scouting around, before we had decided on the techniques and extent of the mapping program, which was begun the following summer. Therefore, artifacts from section 28 are an interesting but uncontrolled collection. They seem to represent the whole range of PaleoIndian tools characteristic of this valley (Fig. 60).

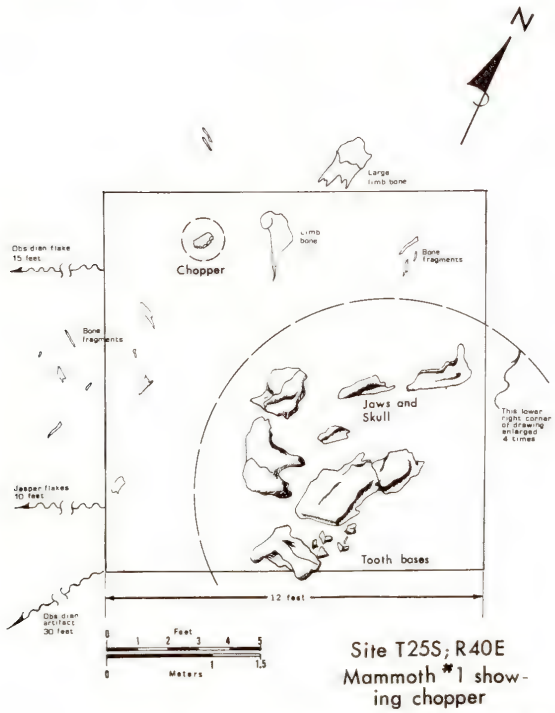
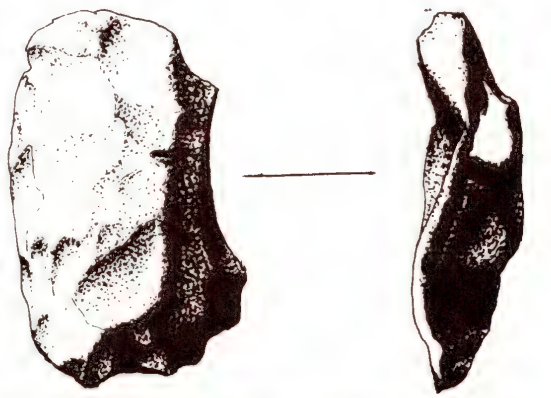
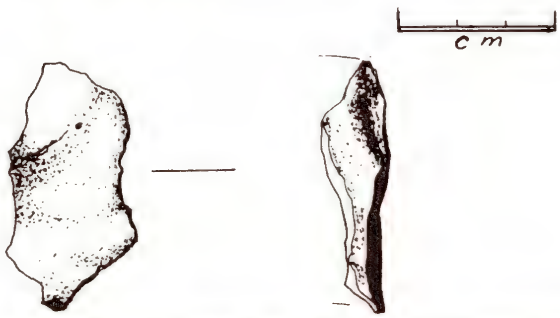


FIGURE 58. Surface scatter of bone fragments of Mammoth #1.



Chopper, found and photographed with bones of a Proboscidean, China Lake, Inyo Co. CA.



Weathered Jasper Flake, found 10 ft. SW of Proboscidean jaw and teeth.

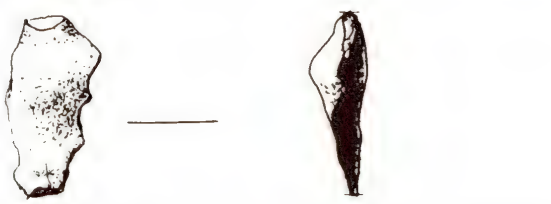


FIGURE 59. Sketches of the chopper and flakes in association with Mammoth #1.

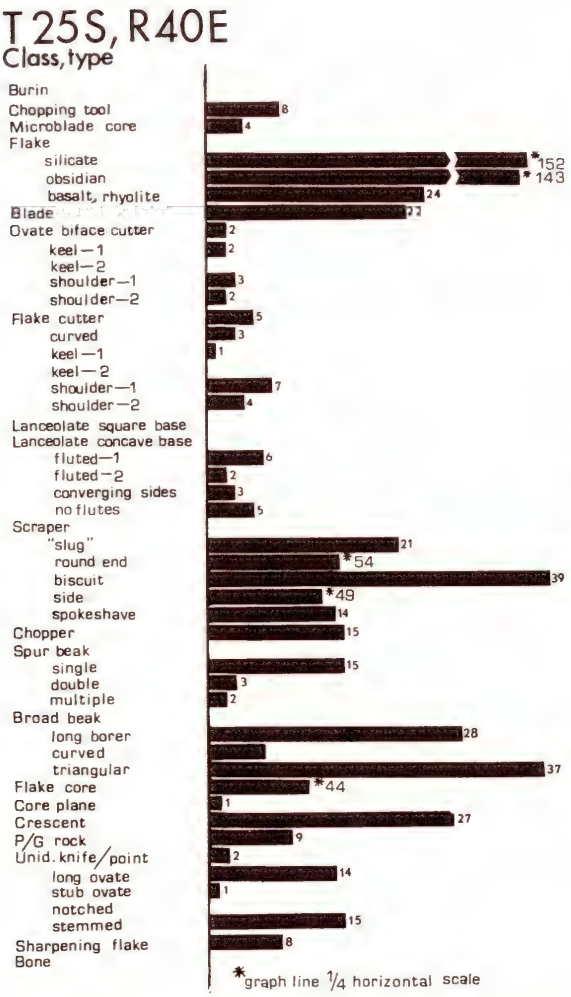


FIGURE 60. Histogram of numbers of PaleoIndian tools and flakes in the uncontrolled collection from T 25 S, R 40 E—Section 28.

Dates.—Mammoth nos. 1 and 2 have not been dated due to the small samples of bone. Mammoth no. 4 has a date of 18,600 ±4,500 years BP (UCLA 1800). The sample for this assay was six lbs. of ivory. The large deviation for this date is characteristic of all the carbon-saturated materials from China Lake sites. It has been stated earlier in this report that every date we have may contain an error of ±5,000 years (George I. Smith, personal communication).

Discussion.—This was a general gathering area for archaeologists as well as for PaleoIndians due to our initial uncertainty about the extent of the study universe which should be considered or the techniques required to map a large piece of Mojave Desert. We had no idea of what the various gravels, sands and "puffy muds" meant in terms of the geochronology of the late Pleistocene lakes; and we certainly did not understand how these natural phenomena could be structured to provide neat pigeon holes for cultural clues. Our own knowledge of these matters has grown as organically and as slowly as a lichen. THIS LEARNING HAS JUST COMMENCED.

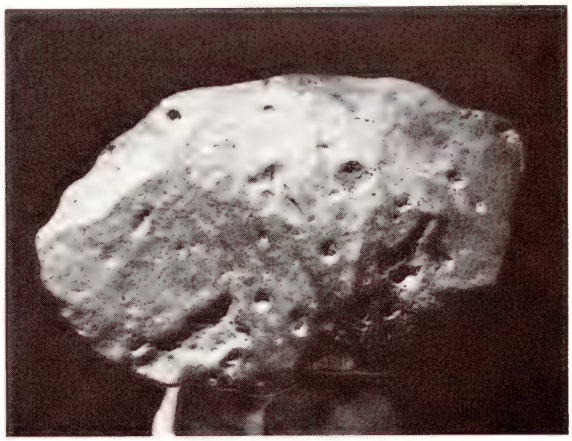


FIGURE 61. Extreme weathering of an artifact attributed to the Core Tool Tradition. This chopper with a broad beak on one end was not only physically but also chemically weathered. Compare condition of the surface with those of Clovis artifacts shown in Fig. 11A.

Site area T-25S; R-40E-28 was of immense value to us. It forced us to see that collecting must be closely controlled and systematically recorded and thereby it generated the mapping system, which is the foundation of all our subsequent work.

The accidental, grab-lot collection from this area was also our first indication that a few of the stone tools from Lake China sites are technologically and stylistically different from most and also are striking because of their extreme weathering (see Fig. 61).

TRANSECT B, SITE 3 (FIG. 62A-D)

Elevation of datum.—Not precisely known; probably about 2,160 feet MSL.

Situation.—On an old gravel bar which projected into the lake during low stands. This bar or spit lies between two fossil drainages shown in Fig. 62A.

Surface deposits.—A thin layer of coarse gravel and sand covers a vesicular silt. Nothing is yet known of the stratigraphy at this locus.

Fauna.—There are virtually no animal remains. Only two fragments of bone of a medium-size creature were found.

Cultural activities.—Transect B Site 3 appears to have been an intermittent camp where the inhabitants were occupied with manufacture of gear, small animal hunting and exploitation of marsh resources such as reeds for mats; rhyzomes, roots, tubers, materials for cordage and textiles; and pollen. The presence of small, delicate, finger-held tools suggests that fine manufacture was one of the activities of the various campers

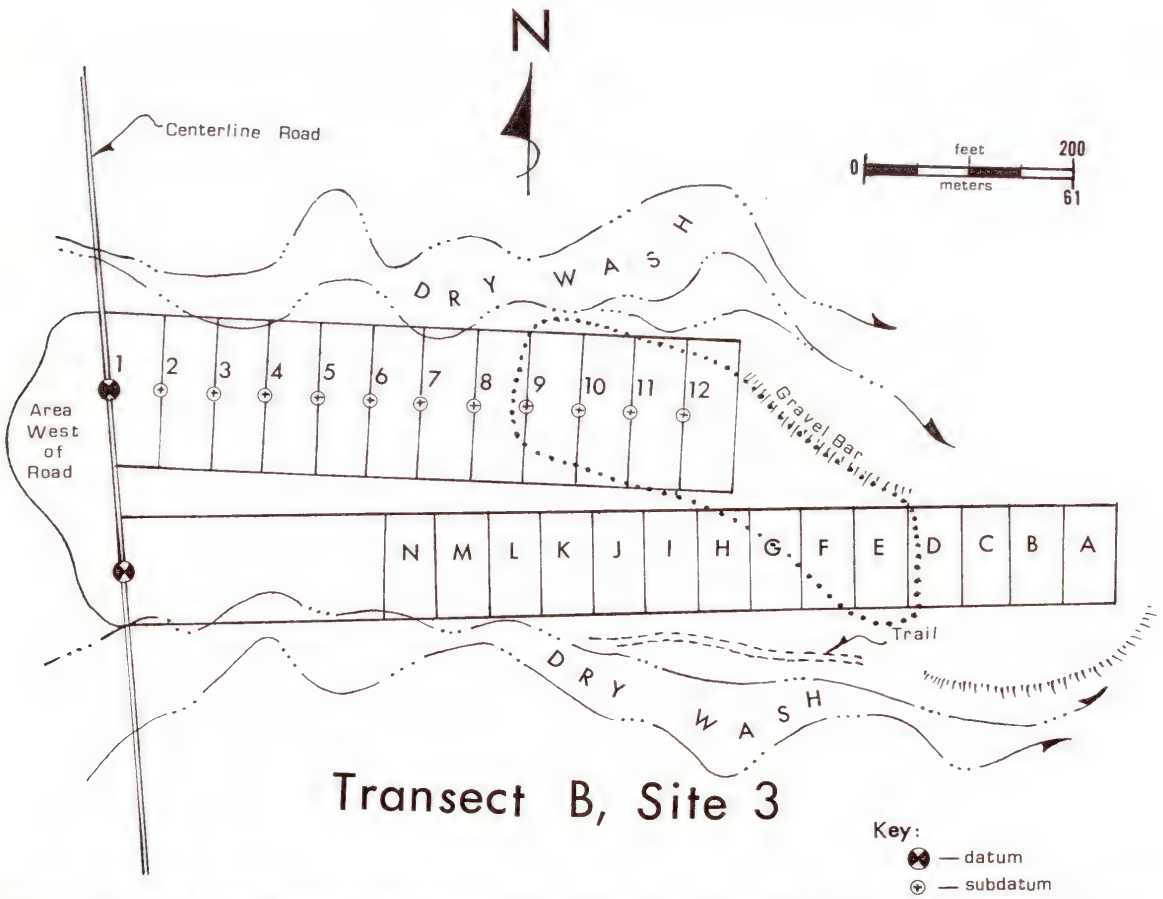


FIGURE 62A. Transect B Site 3, showing subdivisions into collecting areas. Heavy dotted line surrounds cultural concentration area.

on this bar. There are also numerous little cutters, clues to refined trimming operations.

Paleocultural affiliation.—This is a late PaleoIndian locality, which could only have been used after a major recession of Lake China. The tool inventory includes two lanceolate knife/points of different styles expectable at Fluting Co-tradition use localities in this lake valley. One of these objects has ovate sides, whereas the other is parallel (Fig. 62B). A single fragment of a small, unidentified point was also collected, and probably represents someone's brief visit to the locality during later times. However, the shore area at Site 3 evidently was most frequently used by foraging bands during a very late PaleoIndian phase.

Artifacts.—This area of sites is remarkable for the wide variety of stone used by its periodic inhabitants: mottled jasper, chalcedony, Sheep Springs agate, basalt (from Panamint Butte?) and obsidian. This diversity tells us that people came from many different directions to make seasonal use of the Site 3 segment of lakeshore.

General patterns of toolkits from these sites fit with other patterns in the basin but frequencies of diagnostic objects are more closely similar to the Henry Site (which is probably very late) than to Stake 25, which we postu-

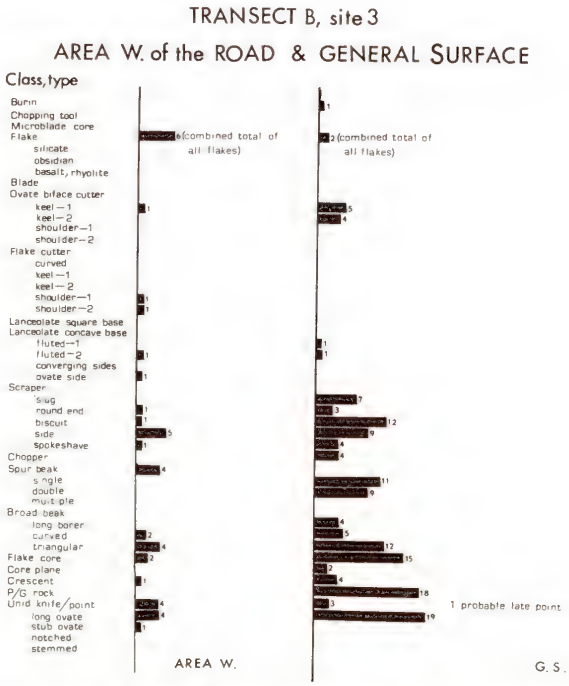


FIGURE 62B. Transect B Site 3: Areas west of road and general surface, histogram showing numbers of artifacts.

late to be early. Differences in both age and culture are inferred, but must be scaled statistically.

Dates.—No datable substances have been found at Site 3 and as yet no excavations have been made in search of them. This should be done. As a mattrer of fact, we should eventually try to date every site we have mapped by fitting it into a scheme of geochronological episodes: high water, low water and pedogenesis. Meanwhile, we can only approximate site dates by extrapolation. The beach locality seems to have been inhabited before two final, high lake transgressions, which covered Stake 1 with successive lacustrine layers separated by a weak soil dated 2,465 ±180 years BP (GX3445). Like every other date on our carbonate-loaded samples, this one may be off by ±5,000 years and should be regarded very critically.

Most likely, Site 3 was used during a pedogenic interval between 7,000 and 11,000 years before the present.

Discussion.—Transect B is a strip about 9.5 km in length and 0.75 km wide, running along the east side of Centerline Road in the middle of the bombing ranges. This strip took us across ridges of gravel and sand, at time intercepting a former shoreline so that we walked over clods of puffy mud, blindingly white with alkaline efflorescence. In this valley, formations of this sort are exposed layers of lacustrine clays.

Site reconnaissance of Transect B began as soon as we reached dry land north of Centerline Road causeway. Just north of the lagoon, we began our routine of alternately walking and driving in pairs beside the road and soon commenced finding site traces on low ridges of sand near the shore of present-day China Lake. Sites were numbered in sequence as we found them: 1, 2 etc. through 5. Site 3 was the largest and most productive. It obviously had never been pot-hunted and gave us some idea of what the beach bar at Pleistocene Lake Mojave (Campbell 1937) was like before repeated visits by collectors.

Site 3 was not mapped with a plane table due to lack of time. Instead, we laid out two strips of different lengths, divided them into narrow transverse sections, and collected each section as a unit, sometimes working on hands and knees. In addition, test squares were staked out within the sections of Strip A-N and the entire gravel layer was screened. This tactic was unproductive. We had not yet learned that *buried material is buried much deeper and is associated with a soil.* At Lake China, soils I and II are associated with clinkers of flaggy sandstone. We have yet to learn the diagnostics of soils III and IV.

THE BASALT RIDGE
FIGURE 63A

This is an amazing site area. It appears to have everything we have needed for five years to answer questions

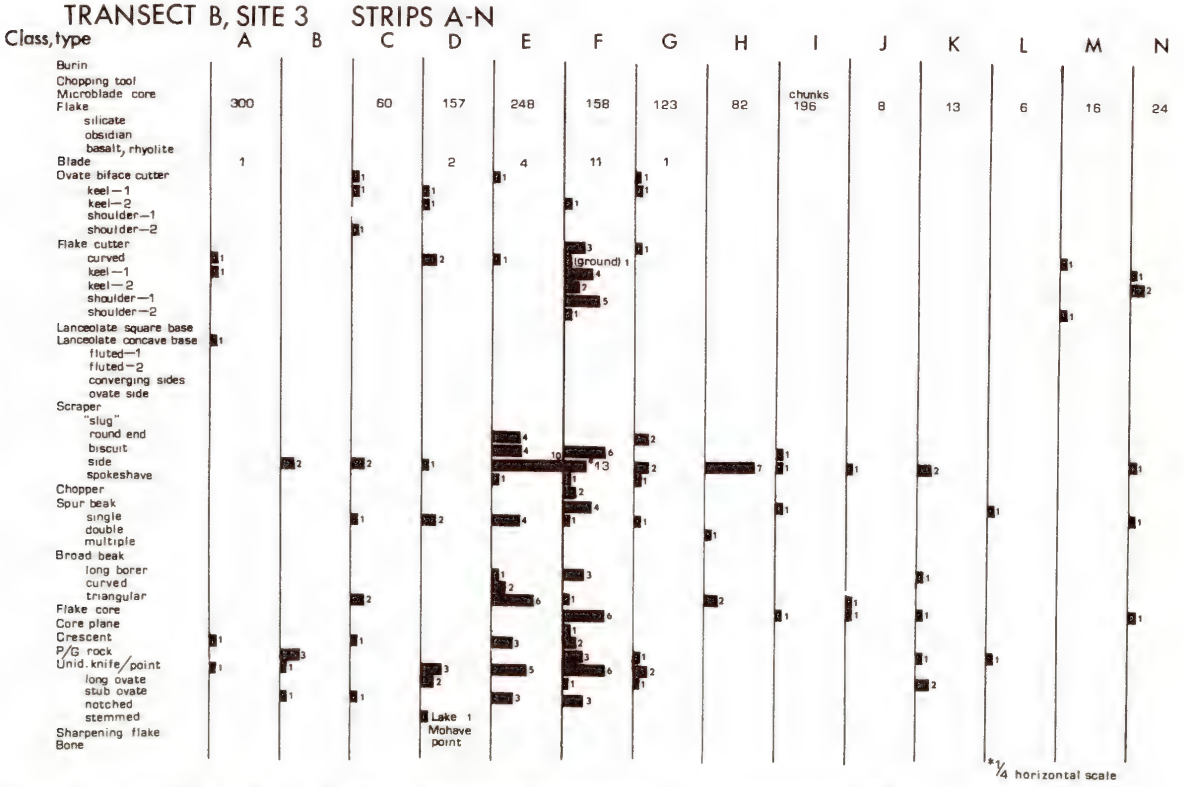


FIGURE 62C. Transect B Site 3, histograms showing numbers of artifacts in sections with letter designations.

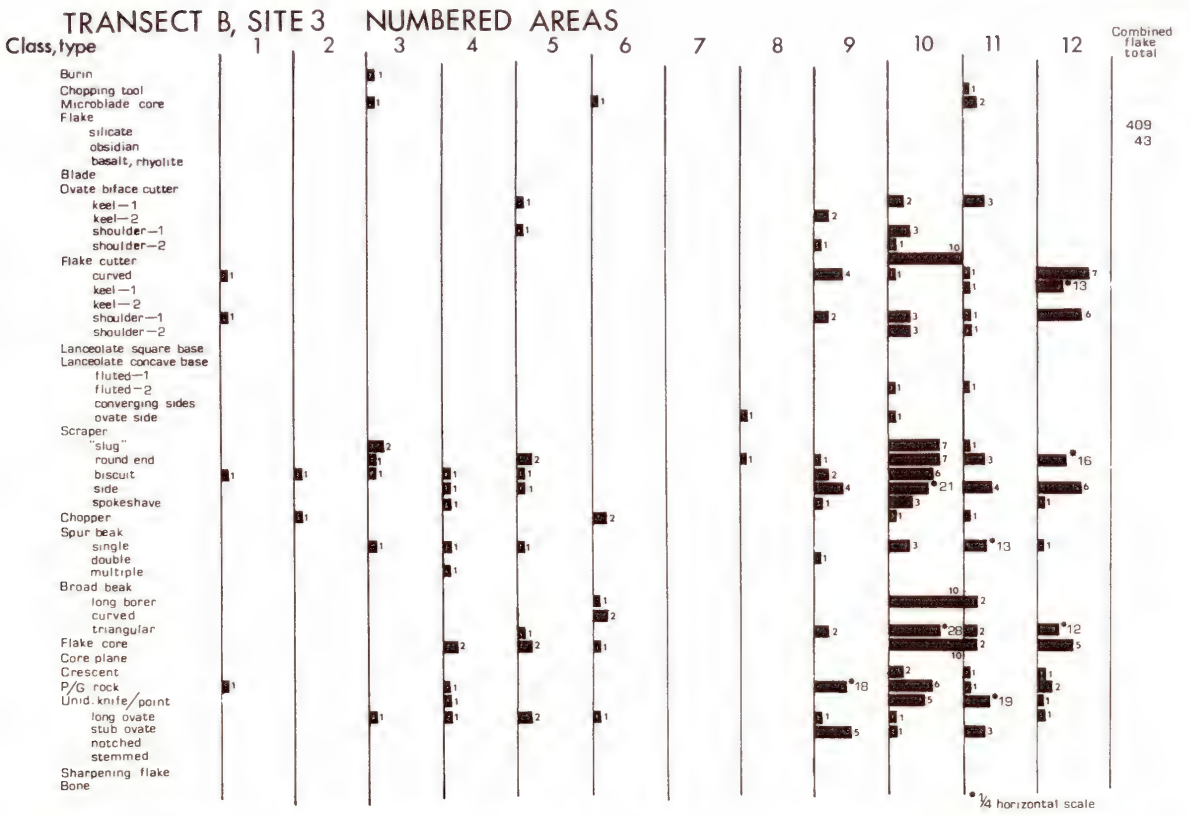


FIGURE 62D. Transect B Site 3, histogram showing numbers of artifacts in section with numbered designations.

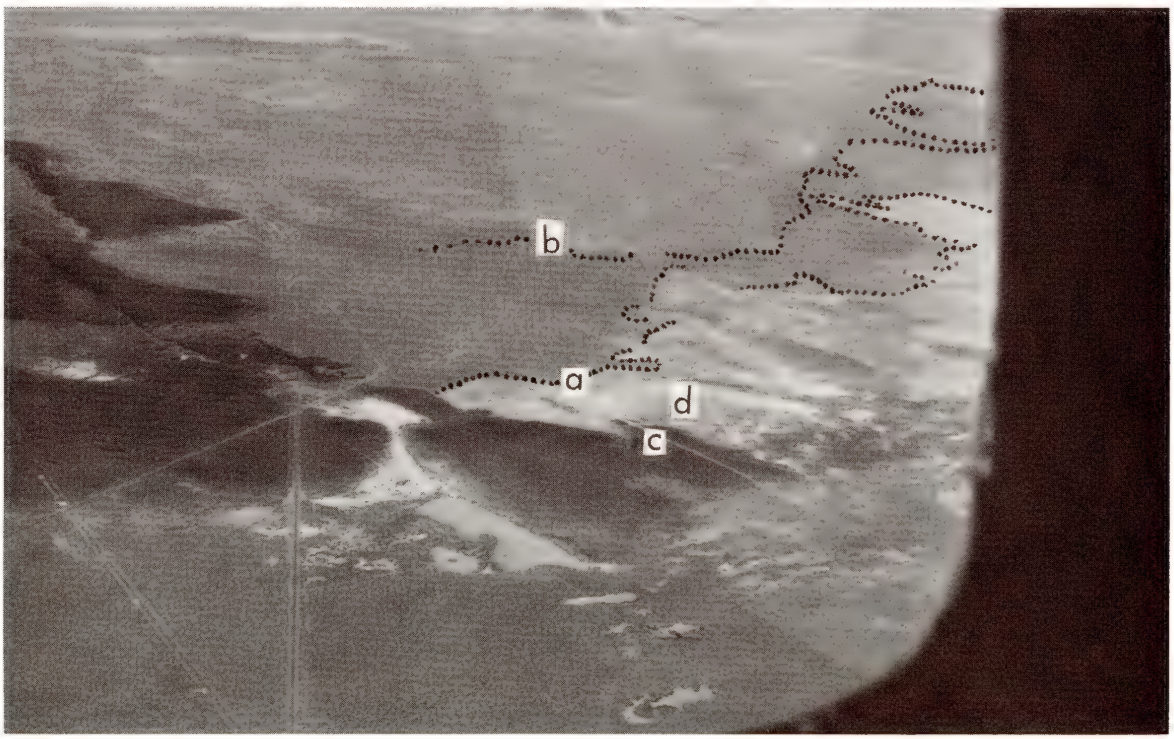


FIGURE 63A. Airview of CRBR area, taken from a light plane: a) 2,219 foot shoreline; b) possibly the 2,240 foot shoreline; c) Basalt Ridge datum; d) CRBR Site Area #1 datum.

FIGURE 63B. General surface just west of Site Area #1 showing rough texture, fragments of mammoth tooth enamel, and broken, basalt biface. Black and white checkers, upper right, are 1 inch long.

about cultures, ecological changes and human-animal associations. The site has charcoal and microfauna as well as megafauna and artifacts.

Elevation of datum.—2,234 feet MSL (stake at south end of the Basalt Ridge).

Situation.—In the center of this locality there is a basalt outcrop that would make an ideal lookout station—a shelter and blind in one. There are also flat crests for camping; stretches of beach that clearly were convenient places for butchering and processing large prey animals (whose fragmented bones are entombed in the clays); and all these activities focussed on the shallow, marshy bay. This was a natural trap.

Surface deposits.—Surfaces in this unusual locus are as complex and varied as are the subsurface formations (Fig. 63B). If one walks from the middle of the old embayment toward the Basalt Ridge, there is continual change. Starting on a bed of tough, white alkaline clay, the walker crosses an imperceptible shoreline where bone and tooth fragments are distributed in a line (Figs. 63C-D), mixed with flakes, artifacts and gnarled fragments of carbonate crust. Some of the bones are charred. (This latter material, in a mixed sample of bone and a charcoal lump, have been sent to UCLA for a ^{14}C date).

Slightly higher up the slope there is an outcrop of telltale "flaggy sandstone" from an erosional exposure of an indicator level—a paleosol. Stratigraphic relationship of this particular soil and the animal remains indicates the kills were older. *It will be important to date this particular paleosol when we return to the field.*

Fauna.—Underfoot, beneath the duricrust there are

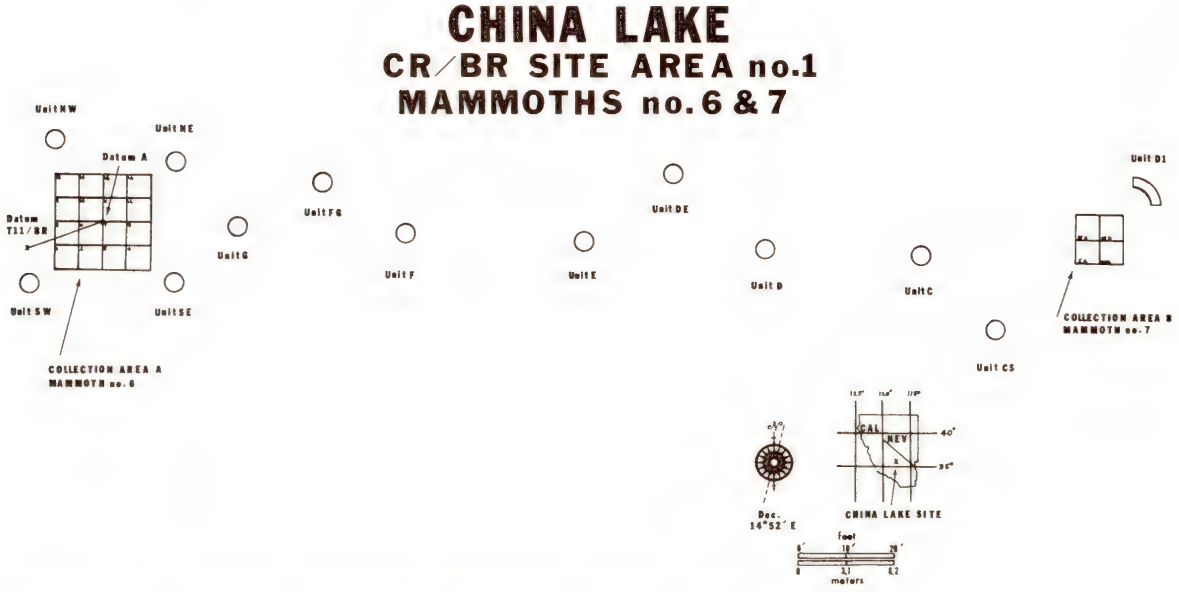


FIGURE 63C. Layout of test excavations along a shoreline (3) beside Site Area #1.

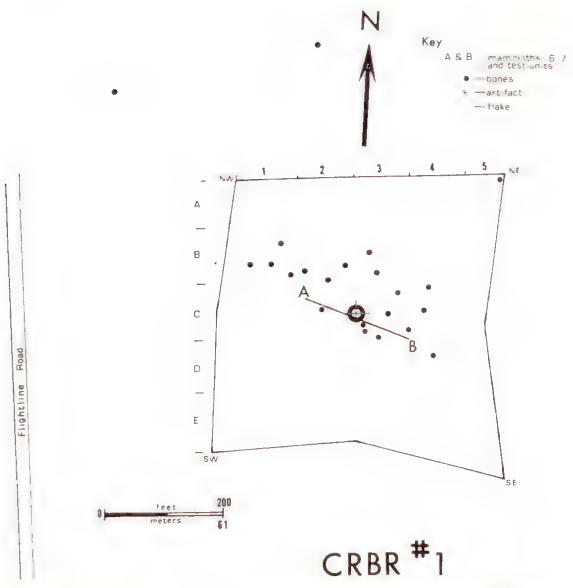


FIGURE 63D. CRBR, Site Area #1, distribution of surface bone. The linear configuration suggests this was probably a shoreline, used as a mud-trap for large animals.

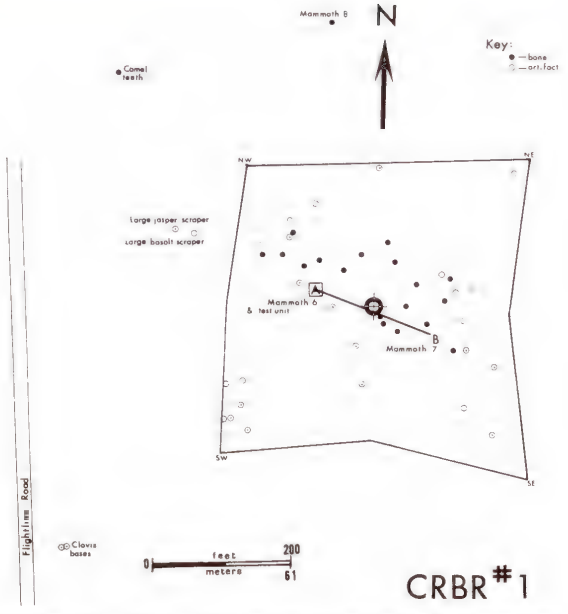


FIGURE 63E. CRBR, Site Area #1, distributions of bones and field-recognizable artifacts.

stratified layers of hard whitish-green clay, interbedded with thin reddish separators. This stratigraphic sandwich contains smashed bone and teeth of mammoth, horse, camel and also smaller creatures such as vole, shorebird and fish. Both surface and subsurface contain mollusc shells (three species of freshwater snails): *Valvata humeralis* (Say), *Helisoma newberryi* (Lea) and *Vorticifex effusus* (Lea). These animals are known as fossils in the basins of Lakes China and Searles but no longer live in the Great Basin since their habitat is bodies of perennial freshwater. (D. Taylor, pers. comm.)

The three snails appear to have been associated with a high stand of the lake when no people or mammals were in the immediate area. The animal remains, however, can be accounted for in part by human activity during a subsequent episode of drier climate and lowered water. One of the most interesting discoveries attendant upon this work has been the rapidity and constancy of climatic microcycles and macrocycles as they are reflected in changing levels of Pleistocene Lake China. This lake was very shallow even when full, a situation that makes it a more sensitive measure of water supply changes than any of the deeper lakes in this chain. The geochronology of Lake China is of great importance, but still remains to be unravelled.

As a surveyor proceeds uphill from the shore he walks up a slope of coarse sand containing or covering Clovis flakes and tools. At the crest of this low hill there is a battlement of basalt and tufa, locus of a datum stake and two tufa dates.

Fauna (see above.)—There are more remains of the megafauna here than at any other site. They are shown in Fig. 63C and itemized in Table 13.

Cultural activities.—Activities of the various Paleo-

TABLE 13

Faunal content of test units between collection areas A and B, Basalt Ridge Site 1.

Unit	Contents
Collection Area A	
Unit NE	Ivory fragments
Unit NW	Shell material
	Possible tooth enamel fragments
Unit SW	Unknown
Unit SE	Unexcavated
Unit G	20 bone fragments
	Ivory fragments
	Obsidian flakes on surface
Unit FG	Tooth enamel fragments
	Bone fragments
	Shell fragments
	Obsidian flakes
Unit F	Large amount of badly decomposed bone, possibly mammoth ulna and radius.
Unit E	10 bone fragments
	Shell
	Young mammal tooth, possibly canid
Unit DE	15 bone fragments
	Mammoth tooth and mandible fragments
	1 bird bone
Unit C	1 unid. bone fragment
Unit CS	3 bone fragments on surface
	1 snail shell
Unit D1	Negative
Collection Area B	
Unit IIIC	Shell
	Bone fragments
	Rodent, shore bird, fish
Unit IVD	Mouse
	Bird

Indians who used this area seem to have been wide in range and to have answered many purposes. There also seem to have been people in the vicinity of Basalt Ridge over a considerable span of time. There appear to have been a few very early people here with a Core Tool Tradition technology. There is evidence of long-term site use by bands with toolkits of Western Lithic Co-tradition; there was an increase of animal kill and processing action during a Classic Clovis Phase. Later, there was a resurgence of specialized hunting on the part of folk who participated in a Pinto Tradition. However, Classic Clovis Phase was the time when "big game hunting" assumed a brief ascendency in Lake China subsistence patterns.

The kinds of action that took place in the favorable embayment were lookout duty; camp life; trapping and slaughter of large animals; preliminary, heavy butchering such as skinning, dismembering and bone smashing; light butchering including preparation of meat, bone and organs for immediate consumption; slicing fleshy masses for sun drying or smoking; processing and manufacture of articles made from plants; gathering plant foods; resharpening and manufacture of stone tools and cutlery; and doubtlessly marshland foraging for delicacies and change of diet.

Cultural affiliations.—As noted above, there is evidence of sporadic use of this locality over time by a number of evolving cultures or else by members of a single culture who occupied themselves with different modes of a diverse lifeway, which have left different toolkits distributed over the Basalt Ridge area. At present, these modes (or lifestyles) are archaeologically indistinguishable except for variations in styling of points. They can be classed under the general rubrics of Lake Mojave, Clovis, Pinto and Core Tool Tradition. Of all these cultural manifestations Classic Clovis is the strongest. This relative strength tells us to look further for causal chains. Aggregates of people were larger than previously suspected, hunting was more aggressive and more specialized. Why? There must have been some empirical base for these transformations: cultural or ecological or both.

Ecologically attributable.—During periods when the level of the lake was low and barely filled the bay with shallow water, a special environment was created. It had eight different characteristics considered desirable by PaleoIndians: a lookout post; adjacent grasslands; a nearby animal trap on the boggy shoreline; marsh foods and products; good camping surfaces; work surfaces near the kills; and a position downwind from the grasslands and pastures.

Culturally attributable.—Changes in hunting technology may have ushered in the Classic Clovis Phase. It clearly was accompanied by changes in tool-making technology such as critical selection of the finest stone; heat tempering of the rock to improve workability; increasingly elegant workmanship. These were cultural changes for which several cultural causes might be proposed.

1) They could have been externally generated by arrivals of new people with technological improvements.
2) They may have been internally generated by societal inventions such as better ways of taking large animals.

Certainly, important innovations are reflected at CRBR by larger populations and greater displays of energy.

Artifacts.—Stone tools, fragments, trimming, finishing and resharpening flakes are liberally scattered along the fossil shoreline. This artifact distribution coincides with animal remains along the beaches at Basalt Ridge sites 1 and 2 (Fig. 63B-F).

Site Area 1 was loaded with flakes shown in Fig. 63F. More than 500 were collected in Quadrant C (the NW1/4) alone. Both site areas 1, and 2 ("The Rock Pile Site"), should be very rewarding for technological microstudies. These areas are either younger than others in the intensive test localities, or else the Basalt Ridge has been better protected from erosion and attacks of weather so that stone in general and obsidian in particular is only slightly sanded. Platforms and bulbs of even tiny finishing flakes are still visible to the naked eye.

Our map of Site 1 (Fig. 63F) indicates that various kinds of stone were used but obsidian predominated.

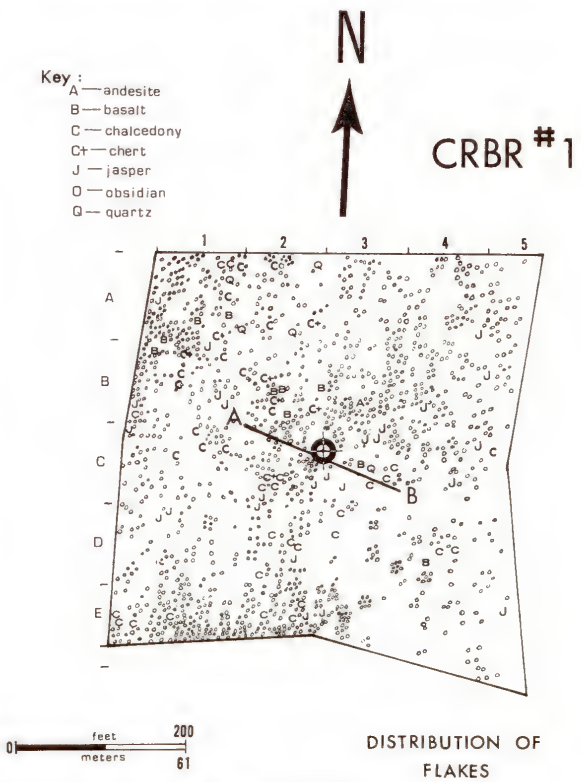


FIGURE 63F. CRBR #1, flake distribution.

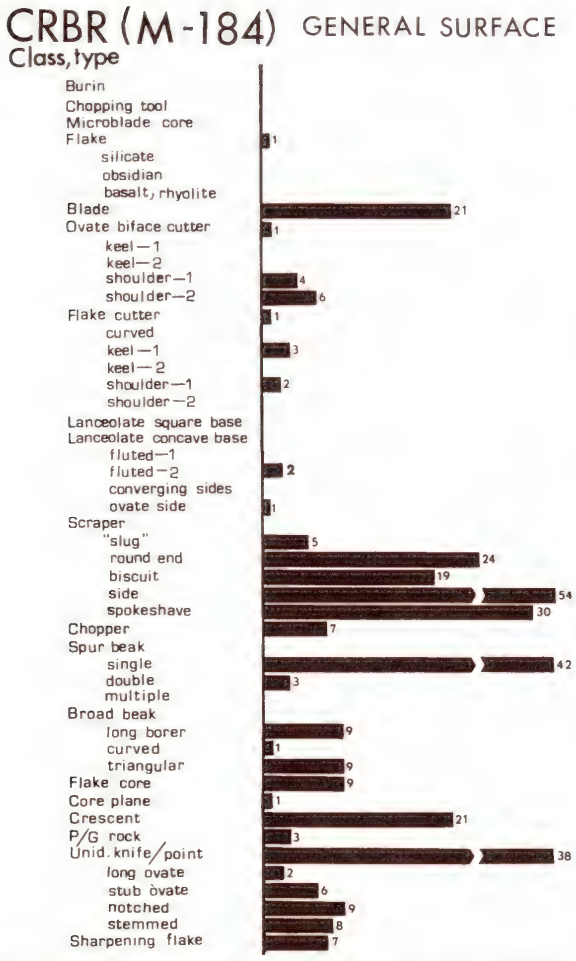


FIGURE 63G. Quantities of tools from general surface collecting (no flakes were collected).

This may reflect either an accident of the inhabitants' direction of travel into Lake China valley, or a conscious, technical choice of material. As an example, fine grained, heat treated silicate rock was preferred for microtools like steak knives and shredders.

Fig. 63G is a histogram of artifact numbers.

Figs. 63I-K indicate distributions of Fluting Co-tradition knife/points (f/bar); crescents (arc/bar) and beaks (curved arrows) in that order. It is interesting that the single "point" is furthest from all bones (of mammoth, camel, horse, etc. as listed in Table 13). A beak is close as are several crescents. PERHAPS CERTAIN MODELS OF CRESCENTS AND CRESCENTICS WERE USED IN BUTCHERING. Most intimately associated with animal bones were an entire area of pounding/grinding rocks at the nearby "Rock Pile Site" and one such rock against a buried mammoth bone, *in situ* in the Basalt Ridge Site 1 test pits.

Steak knives are lumped under the rubric of "saws." They were recognized late in the initial scan and, therefore, had not been included in the roster of tool classes. They have a high frequency in this locality as noted in Fig. 63H, and were most abundant in Quadrant C (NW 1/4), which was closest to the shoreline and to butchering and processing action.

Quadrant A, the SW1/4 of Site 1 was partly devoted to processing and was in part a general camping and tool preparation place. In this quadrant, we harvested 472 trimming flakes, of which 58 turned out to be tools upon close inspection. These, unfortunately, were not recognized in the field and, therefore, are not shown on the artifact distribution map (Fig. 63C). This oversight is a good example of the human error factor that bedevils our system.

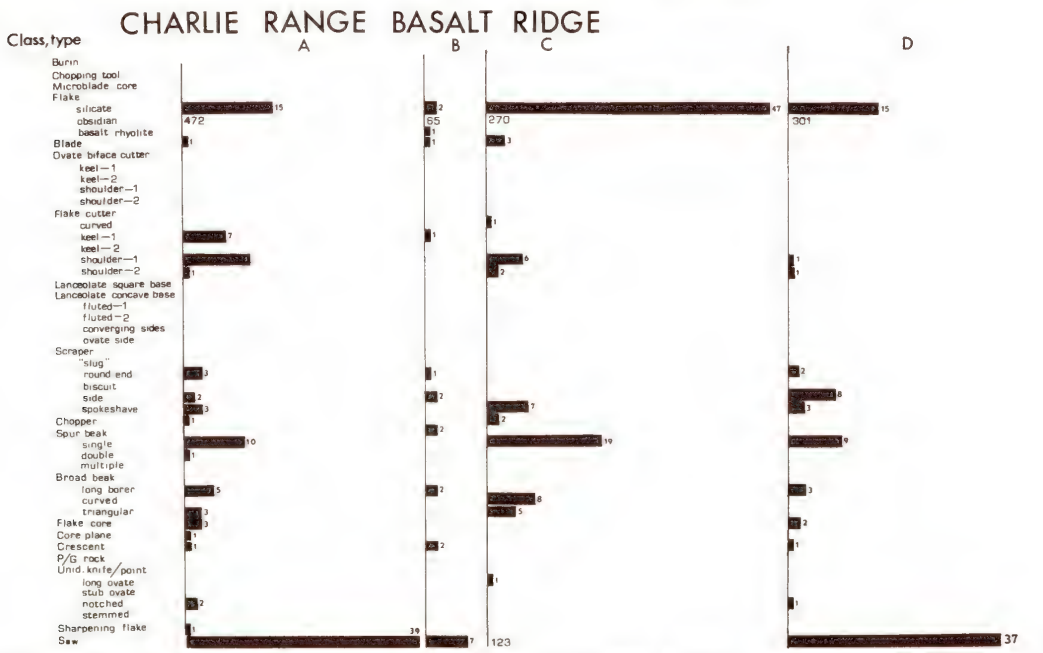


FIGURE 63H. Quantities of tools and flakes in the 4 quadrants of Site Area #1. Note concentrations in A and C.

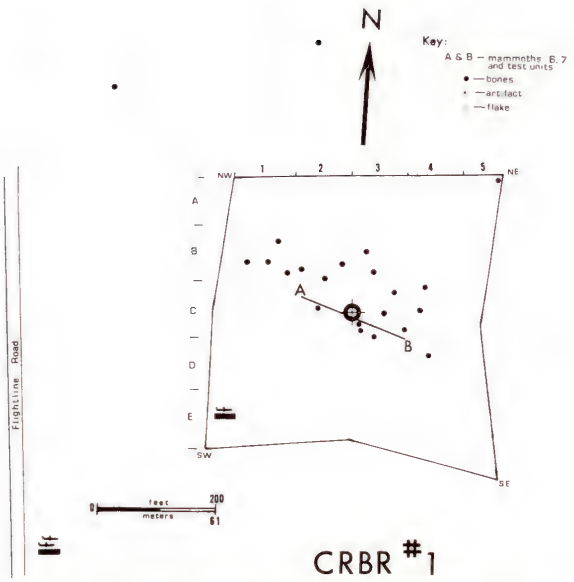


FIGURE 63I. CRBR Site #1, distribution of Fluting Co-tradition knife/points. Note that of all the diagnostic tools shown, this fluted object is furthest from the mammoth, camel and horse bones. Pounding grinding rocks were closest (in direct contact with bone); a beak and 2 crescents were next. (Knife = f/bar).

Dates (and lake levels).—A dated earth sample, possibly a soil, was taken beside Collection Area A and Mammoth no. 6 (Fig. 63C). The date is 10,800 ±300 ^{14}C years BP (GX3446). This layer of dense, calcareous clay probably was formed at a time when the lake was deep and still at this point; oxygen was not constantly stirred into the clay bottom and, therefore, this deposit has a greenish color. However, the water had receded to a lower level by the time people camped and worked near the bay, and the green clays were part of the bottom ooze along the shore. This sticky material was an ideal large animal trap. The bigger the animal the better.

During the previous, deepwater stage, an algal deposit called tufa was deposited along the summit of Basalt Ridge. This tufa has a date of 13,300 ±150 ^{14}C years BP (UCLA #1911A). Subsequently, the lake receded but rose again to cover the ridge, remaining there long enough for a younger tufa to begin forming over the old. This second deposit is dated 12,200 ±200 ^{14}C years BP (UCLA #1911B).

It is important to note that both these dates may be 500–1,000 years too old due to the presence of "dead" carbonates (Rainer Berger, personal communication 1974).

Discussion.—By putting together these three questionable dates, lake episodes controlling human activities at Basalt Ridge can be cautiously reconstructed as follows. About 12,000 years ago, Lake China filled for the penultimate time above a 2,234 foot level and then slowly receded to less than 2,210 feet, creating a small bay in the basalt. While it existed, this bay was a focus for Classic Clovis Phase activities of every kind. Part of the archaeological "sign" is exposed on the beaches, part is buried in the clays, and some is eroding from beneath a sandy mantle.

How can we account for the presence of Pinto Phase knife/points (large and tri-notched) in a Clovis site area? Apparently the main features of the Clovis ecological setting (ridge, beach, swamp environment) were repeated during a final rise of Lake China thousands of years later, (between 3,000 and 6,000 years ago), and foragers with a Pinto lithic technology moved in to take advantage of the bonanza.

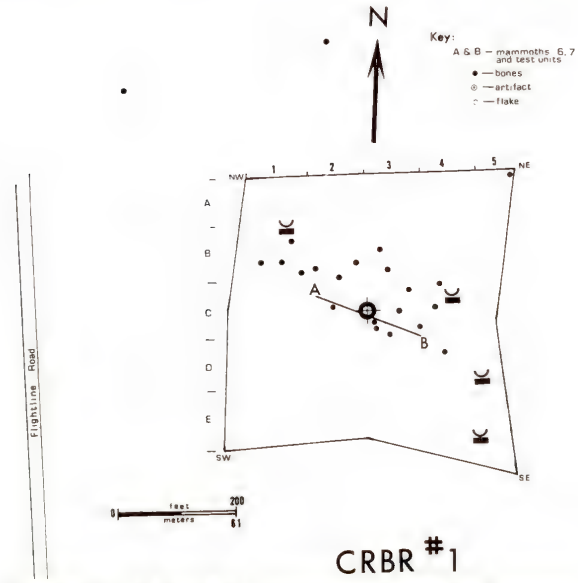


FIGURE 63J. CRBR Site #1, distribution of crescents. (Crescent/bar).

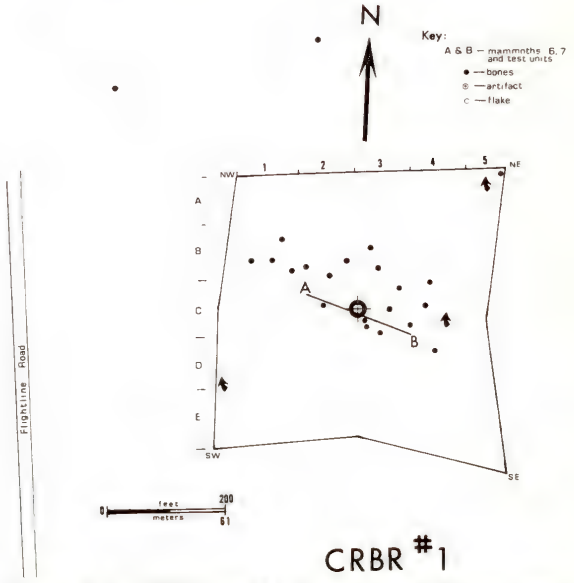


FIGURE 63K. CRBR Site #1, distribution of beaks (curved arrow).

There are a number of archaeologically detectable differences that distinguish Clovis and Pinto inventories at Basalt Ridge. Clovis kill and butchering tools are different, workmanship is more sophisticated and obsidian more sanded. Pinto work is somewhat cruder and the obsidian brighter.

At this point in the China Lake Project, we have secure dates for neither of these phases. It is essential to resume field work after this preliminary report has been published, and design a research program focussed on Basalt Ridge. The search should be for dates; geochronology and ecological changes; foci and extent of different activities (male and female work); and Clovis-Pinto differences in demography and life style. This would go far toward laying a solid foundation for transitions from PaleoIndian to Desert Culture adaptations in the Great Basin.

Other theoretical considerations.—So far in this report, nothing has been said about arts, feelings and values of our PaleoIndian ancestors except in the fantasy stories at the chapter beginnings—the "Establishing Shots." But art and song, magic and social relations were of the greatest importance and must be recaptured by search and discerning inference. The Basalt Ridge locality was a theatre of diverse activity and energy channels. It should be the best setting in this valley for original recording and later rereading of these subtle aspects of PaleoIndian life.

Stakes 1 and 24 will be considered both as separate units and also as a composite (Fig. 64A) because they are spatially adjoined and also share an important segment of Lake China geochronology—cultural materials buried under lacustrine sands. Existence of buried sites was only discovered much later, partly through observations of geologist G. I. Smith, and partly through reworking the two stake maps. At the time these areas were laid out, the two stakes were almost complete unknowns except for a few crescents and bases of fluted knife/points in the locality.

Several years after mapping was begun, we returned to these two neighboring instrument stations and added another feature to the maps: surface traces of a buried soil. Upon restudy of the stake maps, we cautiously predicted that artifacts should exist under the sterile sand at Stake 1, which subsequently was confirmed. This discovery "cracked the code" of Lake China site stratigraphy in this locality.

Stake 1

Elevation of datum.—2,186 feet MSL.

Situation.—This is part of a system of low, sandy knolls, 1.5 to 3 m higher than the surrounding small playas and drainages.

Surface deposits.—The crown of this knoll is mantled with two lacustrine layers of loose, sorted, sandy gravel. The lower of these two beds evidently was exposed long enough for its surface to weather and a weak soil to begin forming. Subsequently, the lake covered the area for a last time and deposited an upper sand, slightly different in both color and texture.

Beneath the loose sands is another lacustrine layer—coarse and cemented, with a weathered surface on which a strong soil had formed. This soil was visible in the backhoe cuts (Fig. 64B) and was identified by G. I. Smith (personal communication).

The strong soil both supported and contained small, finishing flakes made of obsidian and agate. All these flakes had lain on the paleosol long enough to become sandblasted.

Discovery of this long-sought stratigraphy was a composite product of our mapping program and Smith's long experience with the soils and sediments of Lake Searles, an immediately adjoining basin in the Death Valley system. We had wondered about the meaning of a recurrent anomaly—little fragments and piles of hard-baked, gravelly crust which we called "clinkers." Smith renamed the crust "flaggy sandstone." *He confirmed that it was associated with most of the bones and many of the artifacts* and advised us to educate ourselves in its subsurface position and appearance.

We, therefore, returned to stakes 1 and 24 and resurveyed the locality, adding "flaggy sandstone" to the scatter of bones, artifacts and flakes on the original plane table map. The resultant configurations were exciting. The piles of crust fell into groups according to elevation (Fig. 64C), and their plot on the maps indicated circular deposits of artifacts and crust around the gentle slopes of Stake 1. Erosion probably was eating back a buried soil associated with cultural material creating these deposits. This hypothesis was easily checked by excavation (note Trench 2, just below Stake 1 datum, Fig. 64A). The excavation revealed cultural/geochronological episodes and stratigraphic relations that explained why sandy knolls in this valley are sterile, but are immediately surrounded by artifacts and an occasional bone, weathering out. Most animal remains are concentrated along the bog traps supplied by nature on edges of swamps.

It is interesting that elevations of the crust remnants seem to fall into three groups (trimodal curves, Fig. 64C) suggesting three superimposed soils. These must be located and examined for traces of habitation floors.

If we are to make valid tests of an hypothesis that this valley contains a few samples of an ancient Core Tool Tradition with PaleoSiberian origins, the buried paleosols are the places to look for them.

Fauna.—Bone fragments in this vicinity fall into strikingly non-random arrangements that appear either to delineate old shorelines or else the eroding margins of old soils. An excellent example is the arcuate line

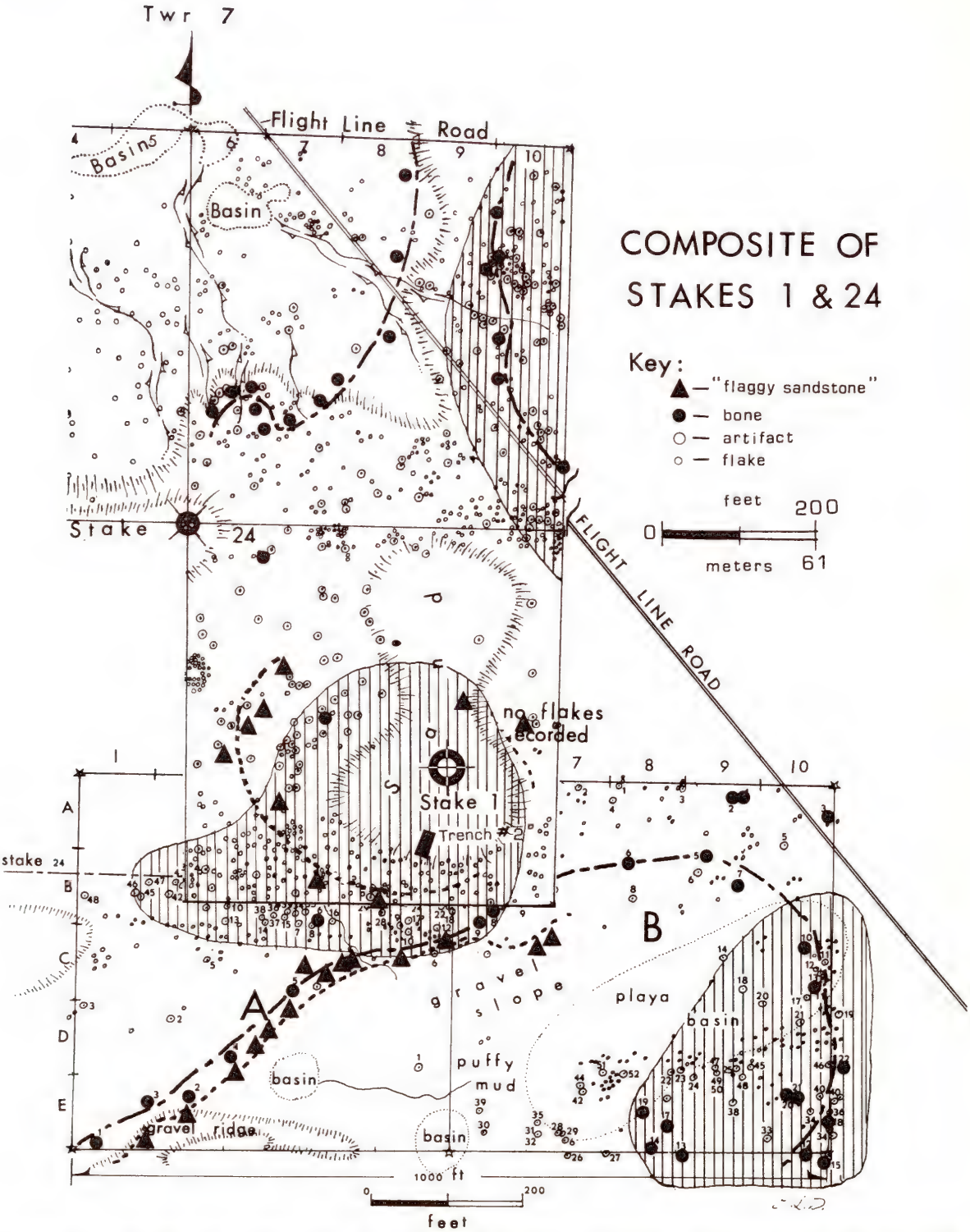


FIGURE 64A. Composite map of Stakes 1 and 24 showing arcuate patterns of bones (black circles) and "flaggy sandstone" (black triangles). The "sandstone" crusts are remnants of a strong paleosol shown in Fig. 55. This soil is directly associated both with bones and artifacts. Striped areas show artifact concentrations.

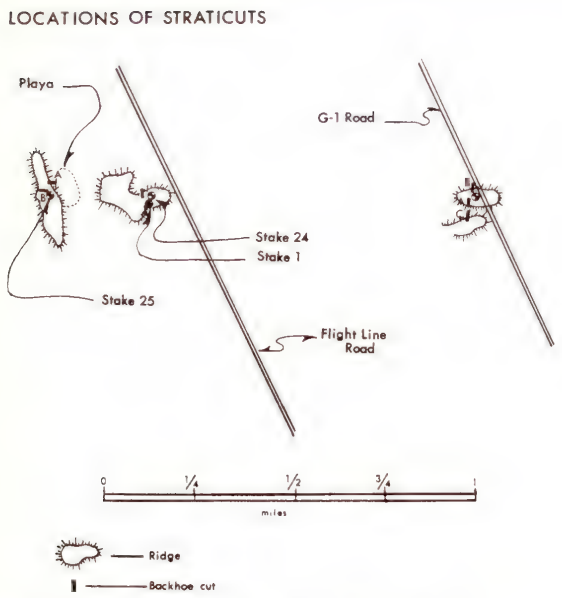


FIGURE 64B. Locations of 1973–74 backhoe work.

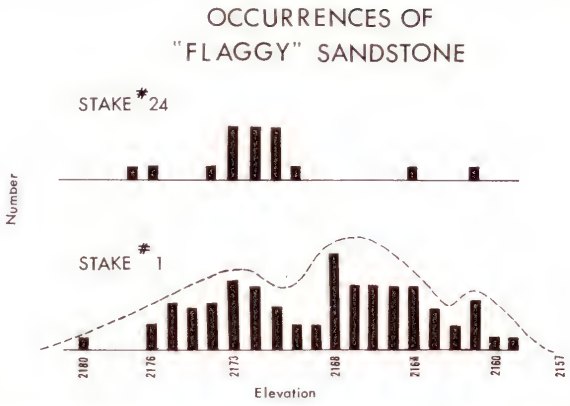


FIGURE 64C. Histogram showing frequencies of "flaggy sandstone," remnants, grouped by elevations. A weakly defined trimodal curve suggests that *there may be three soils*.

of bone and flaggy sandstone in Fig. 64A, running from the southwest corner of Stake 1. Beginning in square 1E it curves across to 9B. There is another concentration of bones and artifacts in the extreme southeast corner of the same stake. These concentrations are marked with a cross hatch. In the southeast corner, there appears to be both an arc of bone from 10C to 10E and also an open scatter of bone fragments in 8E. In this particular locality, artifacts seem more closely associated with the arcuate pattern than elsewhere in Stake 1. This correlation appears again in the northeast corner of Stake 24.

At first glance, there seem to be four intersecting lines: two of artifacts and two of bones. This situation needs further study.

Cultural activities.—Most of the action took place on a strong soil surface, which is still partially covered by the sands at Stake 1. A time bracket of (questionable) radiocarbon dates is given below for this soil.

Activities most easily inferred from archaeological clues are as follows: general camping; probable kills, suggested by the orderly lines of bone; processing of the kills. All other work took place in camp: sharpening and manufacture of stone tools; general manufacture such as cutting, scraping, sawing, shredding, boring and chopping operations. It is unfortunate that the long sandblasting to which every piece of stone on these sites has been subjected, has left almost no traces of use wear. Exploitation of the marsh has also left only slight vestiges in the form of shredding tools for roots and pounding/grinding rocks—particularly a few which are edge ground—for processing of roots and tubers.

Probably these peoples hunted, gathered and camped in other places as well, but such sites have not yet been identified; and they doubtless used natural traps other than bogs to take larger animals. Gullies with steep banks are a likely alternative (Wheat 1967:80) such as the Olsen-Chubbuck bison kill. In the Lake China area, we are working in an earlier time range and with bigger creatures. From what we have observed in excavations of three mammoths, a horse, and a *Bison antiquus* skull, most of the kills were single animals.

In the Stake 1 locality, selection of the two low areas at top and bottom of Fig. 64A supports the premise of a primary marsh orientation for plant and small protein foods, and with secondary use of the shores as traps for megafauna.

Dates.—There are several radiocarbon dates for the upper, strong soil level at Stake 1 as follows: 6,775 ±260 ^{14}C years BP (GX3443); and 10,275 ±65 ^{14}C years (GX3442). These roughly bracket the level between 7,000 and 10,000 years BP. The weak soil that separates the lacustrine layers on top has a date of 2,465 ±180 years BP. The cemented layer supporting the strong soil contains small chunks of a paleosol and dates 9,390 ±365 years BP (GX3444).

Paleocultural affiliations.—Various sections of Stake 1, quadrants A and B were visited occasionally and over a long time by small bands of hunter-gatherers. These bands of people, judging by the mingled tools of these occupancies and a study of degrees of physical wear due to differential exposure, belonged to the following techno-cultural sequences: 1) Late Core Tool Tradition; 2) Late Wisconsin Cultures; 3) Proto-Clovis of Lanceolate Tradition (no diagnostics of Ovate Tradition have been found in this locality); 4) Late or Degenerate Clovis; 5) Pinto.

Artifacts and discussion.—As analysis of these sites has progressed, it has become clear that the major artifact of one of these foraging groups was the piece of land on which it chose to live or work. These settings are an archaeologist's glossary for the people's aims, activities and customs—microviews of ways of life.

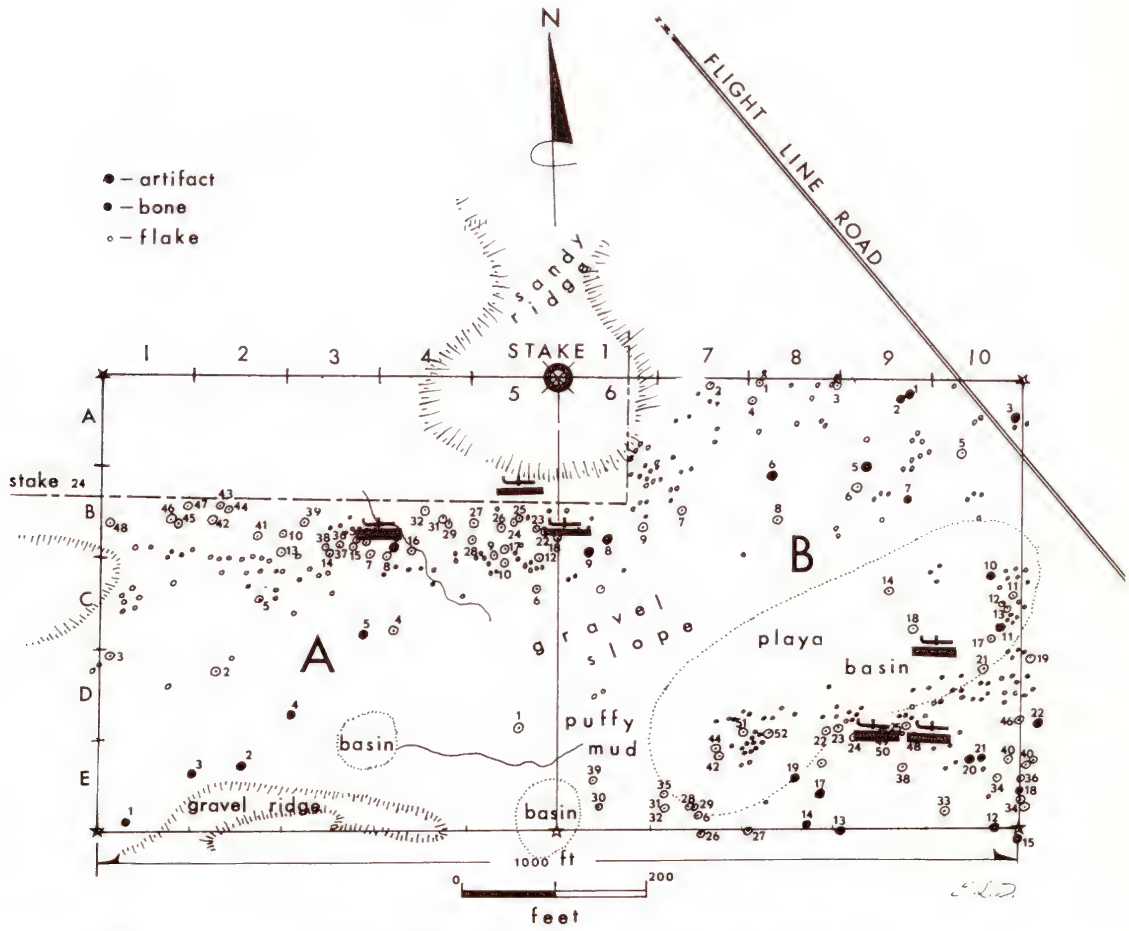


FIGURE 64D. Stake 1, distribution of artifacts, flakes and Fluting Co-tradition knife/points (bar–"F").

After this, the stone tools are messages, which diminish in clarity until they become lost in time.

In presenting these tools, two synoptic methods have been used: a separate map showing distributions of each of four diagnostic artifacts. These were considered to be knife/points of Fluting Co-tradition (Fig. 64D); stemmed objects of Western Lithic Co-tradition (Lake Mojave) shown in Fig. 64E; "gravers" (e.g. beaks) (Fig. 64F); and crescents (see Stake 24 ff). Both the categories and the maps are approximations. Only through such careful attempts did we begin to realize the flaws in our system. There are at least four categories of fluted objects; even more subdivisions under the Lake Mojave rubric; six or more kinds of "gravers" and about half a dozen styles of crescents that intergrade with the work tools called crescentics. Neither crescents nor crescentics are indicated on the distribution maps of Stake 1, although they appear in the histograms. They simply were not recognized in the field. However, they can be mapped in the laboratory later when all site areas are more exhaustively analyzed.

Despite all the omissions and errors, mapping diagnostics *as best we could construe them* has enabled us to delinate activity foci, even going so far as to propose at least one woman's work area in Stake 8A. In the future, we may learn something about a possible Proto-Clovis sequence at Stake 1 by locating the following fragments on the field map to see if they cluster: 1B-45 (chert shim); 1B-13 (chalcedony biface); 1B-19 (chalcedony biface with multiple flutes removed from both sides). In addition, a heavily weathered object of Core Tool Tradition, 1A-37, was noted in Quadrant A: "this is a triangular broad beak of jasper, which should be relocated together with three tools of comparable jasper in Quadrant B—1B-40; 1B-52 and 1B-24."

It was further noted that several Classic Clovis saws at Stake 1 indicated second generation flaking, which modified them into steak knives with smaller teeth. Also, most of the flake tools were probably finger held.

STAKE 24

This survey locality is the northern part of the same depression-and-ridge system as Stake 1. However, the

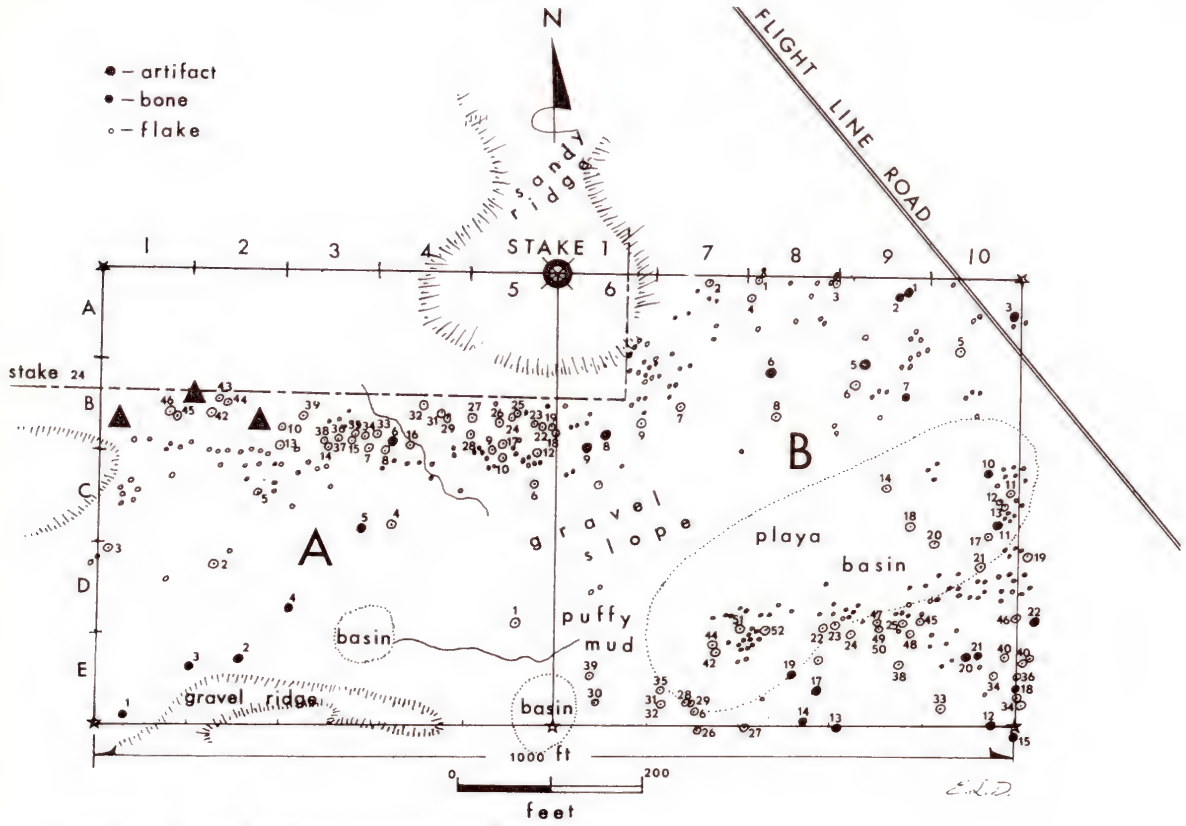


FIGURE 64E. Stake 1, distribution of stemmed objects.

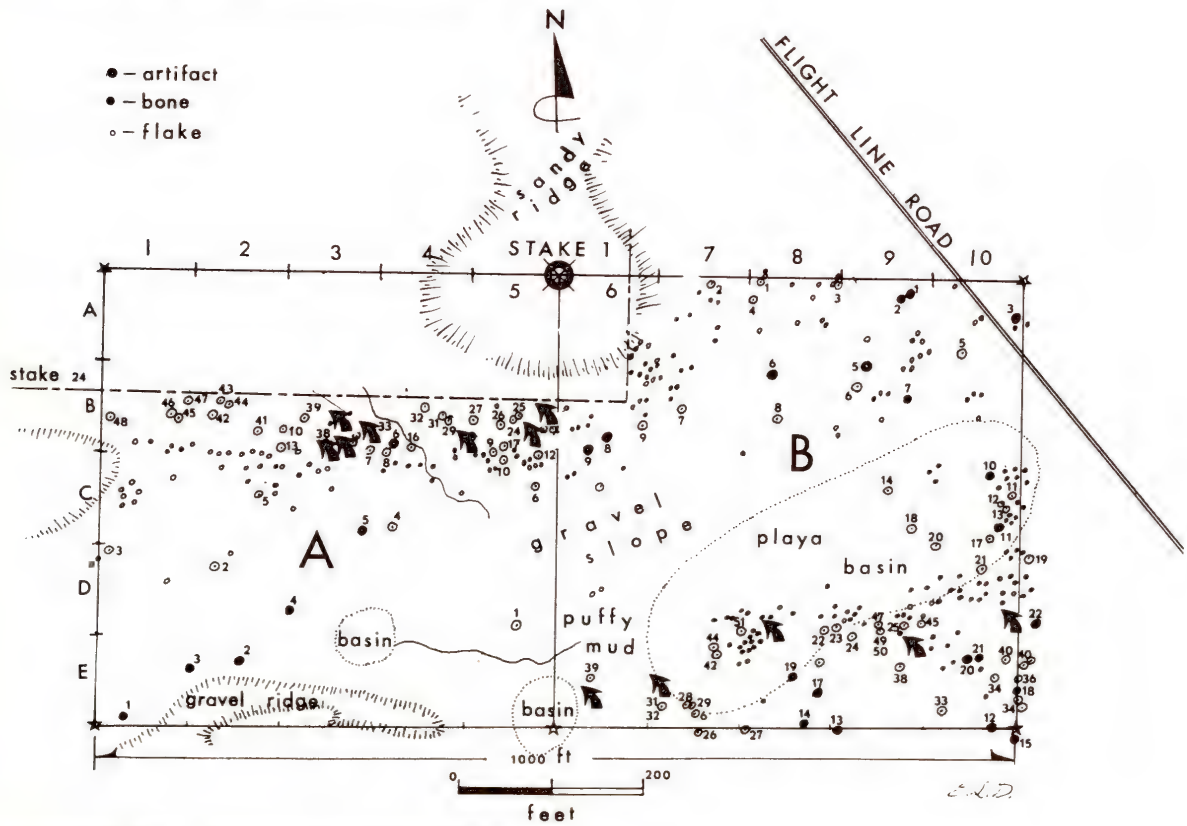


FIGURE 64F. Stake 1, distribution of all types of beaks.

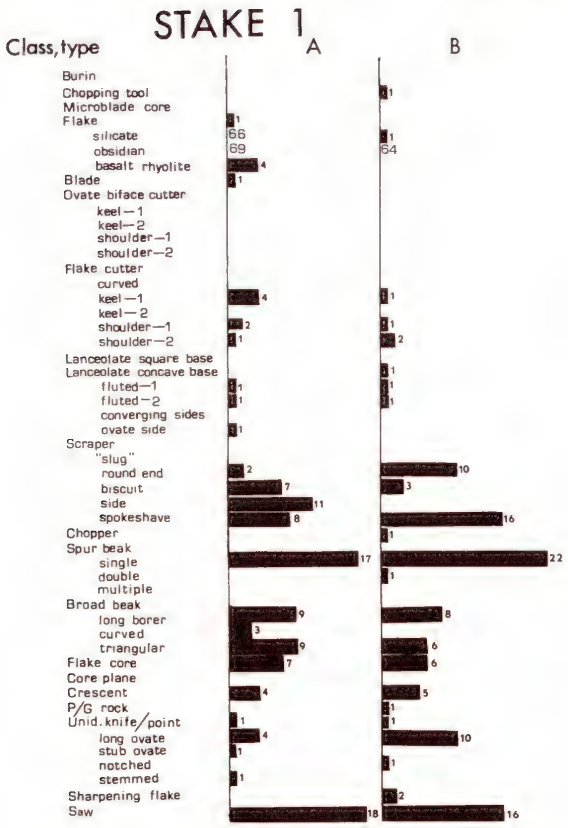


FIGURE 64G. Stake 1, histogram showing frequencies of various artifact classes. Flake score shows an even balance between amounts of obsidian and silicate on this locus.

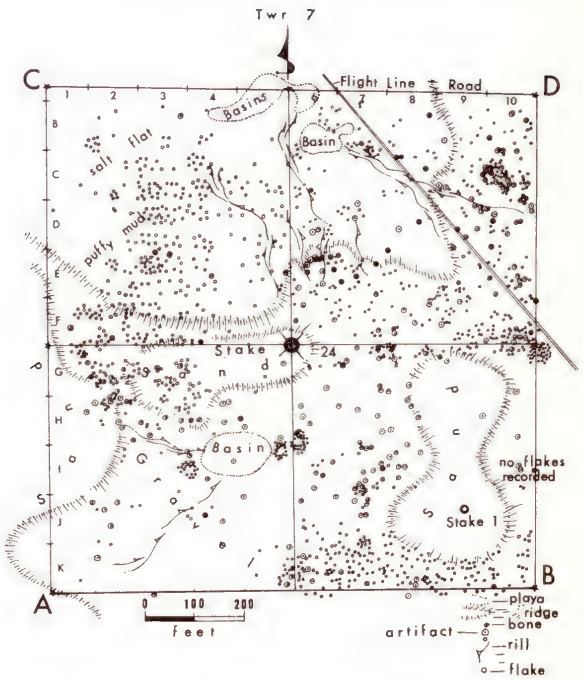


FIGURE 65A. Plane table map of Stake 24 showing topography, bones, and general scatter of artifacts and flakes.

scatters and concentrations of artifacts at Stake 24 are somewhat different from those at Stake 1, giving the impression of being younger and less weathered. The Stake 24 inventory lacks any tools attributable to a Core Tool Tradition. On the other hand, a late or Decadent Clovis assemblage may be present, characterized by a lanceolate knife/point with a square base and no flutes. Also, there are fluted specimens of both Lanceolate and Ovate Traditions.

Different accidents of erosion may have influenced the different tools available on current surfaces of stakes 1 and 24. Stake 24 is two feet lower than Stake 1, *possibly because it has lost the upper member of its lacustrine mantle,* leaving an exposure of late artifacts that had been deposited on the weak soil cover of the lower member.

Elevation of datum.—2,184 feet MSL.

Situation.—Stake 24 datum is located on a slight rise of sandy ground belonging to the same system of residual land forms as Stake 1. The higher surfaces are only 1.5 to 4 m above boundary drainages to the north and south and are being slowly reduced by erosion. This gullying action is creating widening spaces of small rills and salt pans, scattered with displaced flakes, broken tools and an occasional crescent or fluted base (Fig. 65A). Like many of the former living spaces of Lake China valley, the Stake 24-Stake 1 ridge was probably situated near a grassland/marsh interface.

Surface deposits.—Sands and gravels around Stake 24 are comparable not only to those surrounding Stake 1, but also to residual formations on the knolls of other instrument stations. To be specific: the datum stake is usually on a small elevation covered with sterile sand. These sands overlie a coarser gravel. Relations and extent of these deposits need to be tested and dated at a number of stakes—the stratigraphy is a record of the past 10,000–11,000 years of Lake China geochronology. It is also a buried record of human activities.

Fauna.—Figure 65B indicates two distributions of bones, forming arcuate configurations, which originally called our attention to a possibility of animal trap/shoreline connections. The etiology of such patterns might well be cultural, but confirmation will be determined by future work. Unfortunately, the bone fragments were mapped by archaeologists who had one system of recording, and then collected for identification by the paleontologist who had a different set of records. This discrepancy can be corrected in the future. Archaeology, paleontology and ancillary disciplines should be well coordinated.

Cultural activities.—Like Stake 1, Stake 24 was probably used sporadically, by small bands of people, over a long time period. The low ridge was a home base for camping; manufacture and sharpening tools; preparation of gear and foods. The most active locus of tool making and use is at present fully exposed along the east edge of Quadrant D (Fig. 65C).

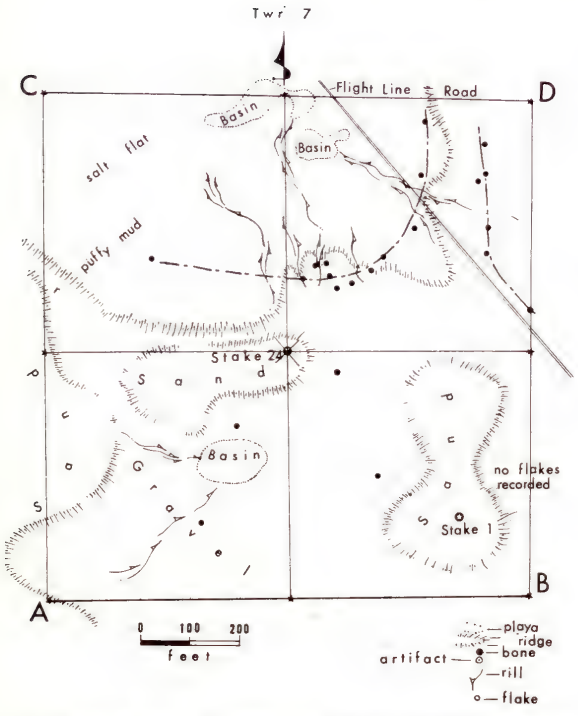


FIGURE 65B. Arcuate distributions of bones in Quadrants C and D vs. random distributions in A and B. These arrangements probably distinguish between situation-specific activities (along shorelines?) and situation-non specific activities in camps.

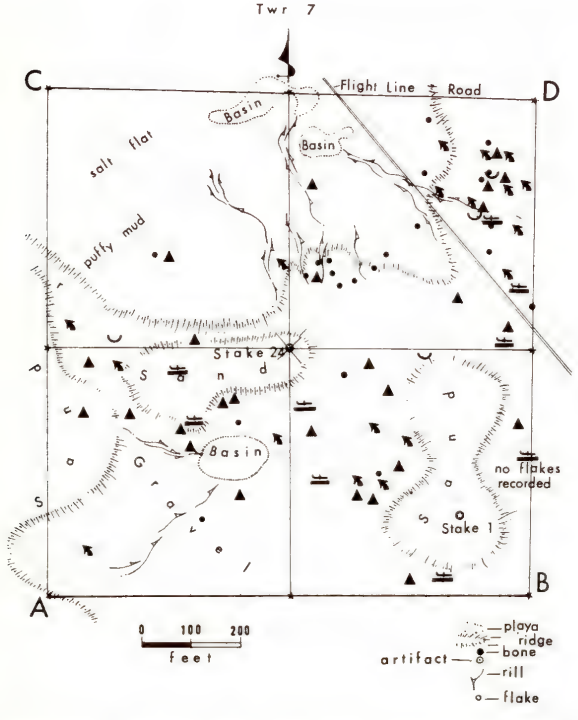


FIGURE 65C. Map of Stake 24 showing distributions of diagnostics: Lake Mojave objects (black triangles); fluted knife/points ("f"/bar); beaks (curved arrows); crescents (arc/bar).

Paleocultural affiliations.—Stake 24 appears to have had less appeal to early foragers than Stake 1. The cultures that can be tentatively identified are Lake Mojave mixtures and Clovis of Ovate and Lanceolate Traditions. Core Tool Tradition, Lake Wisconsin Cultures, Classic Clovis and Pinto are absent.

Artifacts and discussion.—The picture of tool distribution at Stake 24 is probably typical of all the stakes where we have mapped, in as much as every tool and flake has been exposed at least once and some many times as attested by the degree of sand abrasion. This exposure to weather has also exposed them to slope wash, soil creep and wind action. The degree to which these forces acted upon the artifacts has been purely a matter of chance. Most artifacts are probably still buried under sands along the west side of Quadrant A and may be little disturbed. In contrast, active erosion and rill downwash are carrying exposed materials onto lower surfaces in the north portion of Quadrant C.

The open distribution of fluted knife/points shown in Fig. 65D and their close, spatial association with gravers (Fig. 65E) supports a view that "Clovis points" were, perhaps, specialized work tools, considered more valuable for butchering large, tough animals than for slaughtering them.

Crescents (Fig. 65F) also have an open rather than clustered distribution, generally corresponding to that of both gravers and lanceolate knife/points. Similar arrangements of these three classes of artifacts support a view that the northeast corner of Quadrant D was the focus of most intense activities within stake

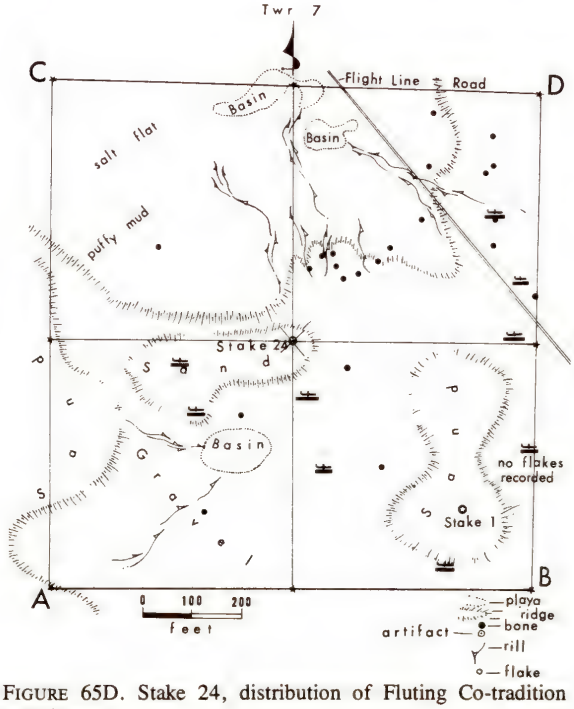


FIGURE 65D. Stake 24, distribution of Fluting Co-tradition knife/points.

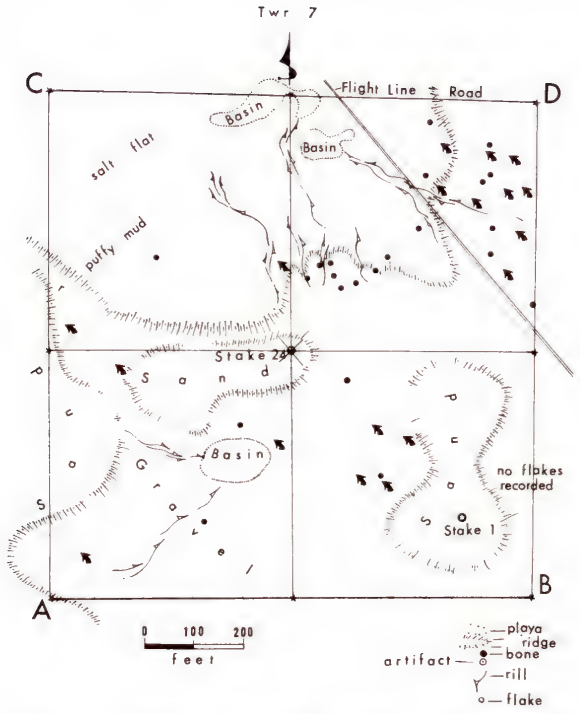


FIGURE 65E. Stake 24, distribution of beaks ("gravers") shown as curved arrows.

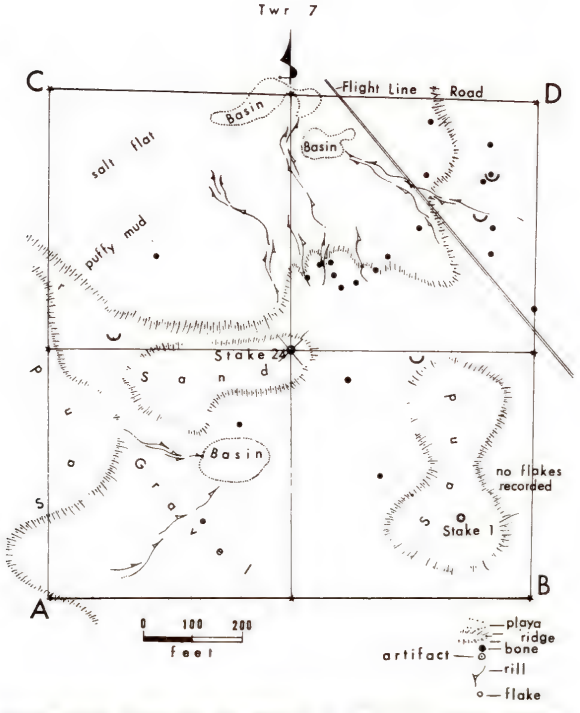


FIGURE 65F. Stake 24, distribution of crescents. These artifacts cluster in a major concentration area in the NE corner of Quadrant D.

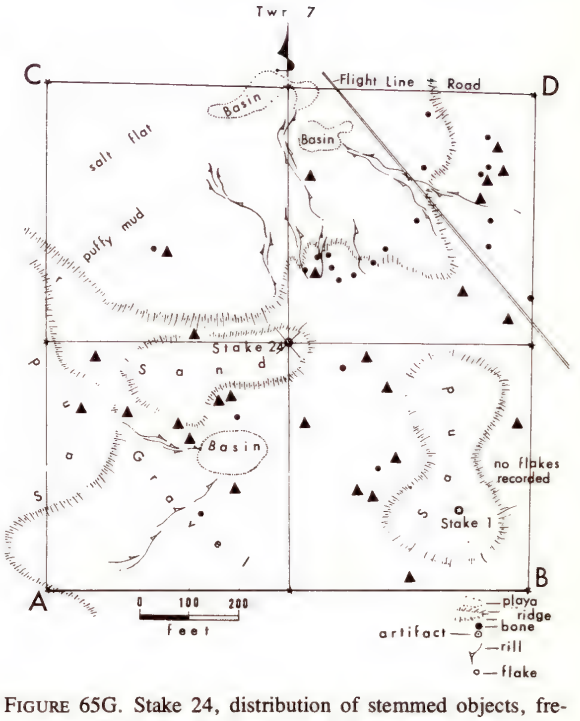


FIGURE 65G. Stake 24, distribution of stemmed objects, frequently called "Lake Mojave points."

24. Stemmed objects, shown in Fig. 65G, also occur in the same area. The histogram indicates that D was also the only quadrant in this stake where spokeshaves were found.

STAKE 7

Stake 7 was one of the first site localities to be surveyed after we established the Intensive Test system. At that time, we had not yet devised a method for including flakes by their approximate distance and direction from recognizable tools that were being plotted and numbered on the plane table. Therefore, flakes are not shown in the general site scatter (Fig. 66A).

Only two Quadrants were mapped: C in the NW 1/4 and D in the NE 1/4 of the stake. South of the stake datum, the surface was sterile—probably because the artifacts are still covered with sand. This possibility should be tested.

Elevation of datum.—2,170 feet MSL.

Situation.—This is the most southerly and also lowest of all stakes in the survey area. It is adjacent to flat expanses that were probably the bed of a subrecent lake and in the past may have been very close to a lakeshore. It appears to have consisted of a central, shallow basin (now being filled with silt), associated with an island and a promontory.

Surface deposits.—There has evidently been considerable disturbance of bones and tools, which lie on

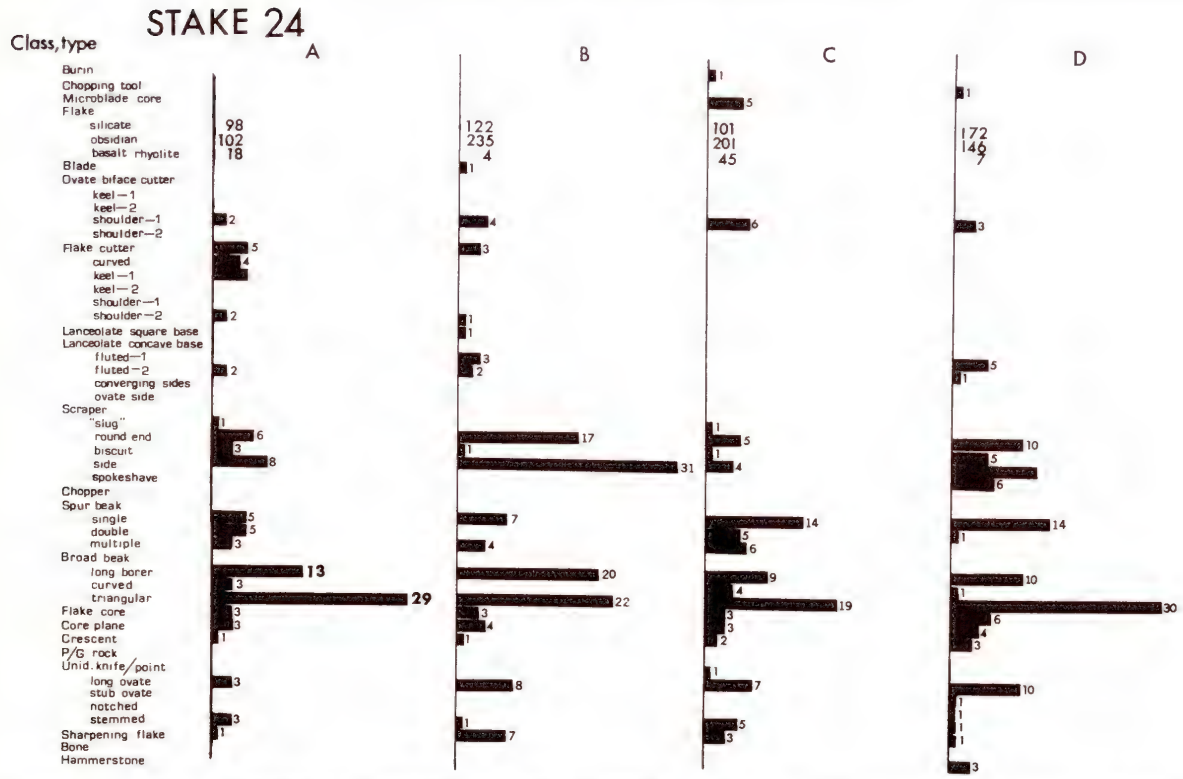


FIGURE 65H. Stake 24, histograms of all Quadrants. Note that flake counts show this locus to be weighted in favor of obsidian. Extensive exposure and erosion of a very late PaleoIndian horizon on top of the weak soil may account for this preference.

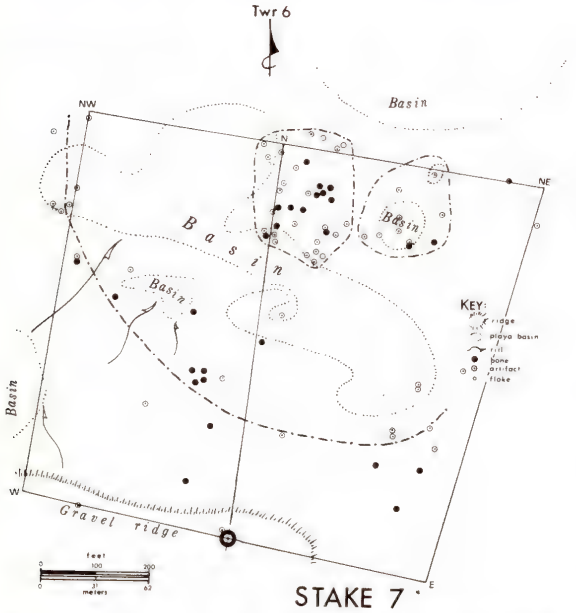


FIGURE 66A. Map of Stake 7, showing total scatter of artifacts and bones.

a thin film of gravel eroding out of more massive deposits. Like Stake 1, this locality was doubtless covered with several layers of lacustrine sands. These sands and an interbedded, weak soil have disappeared north of Stake 7 datum.

Fauna.—A number of fragments of mammal bone were scattered on the north and south sides of the larger playa (Fig. 66B). Tentatively, they appear to fall into three configurations: a loose, arcuate scatter along the south edge and two bone/artifact clusters on the north side. A fairly consistent association of bones with beaks ("gravers") is interesting and supports a view that these specialized artifacts may have been used for incising bone (see Fig. 66C).

Taxa	*No. of fragments*
Bison sp.	1
Mammuthus sp.	?
Camelops sp.	6
Equus sp.	1

Cultural activities.—The locality has not been sufficiently studied for clear patterns of cultural use and cultural toolkits to emerge, with two exceptions: a single Fluting Co-tradition knife/point (Fig. 66D) indicates at least one hunting or butchering episode by people of a Clovis tradition; there was also pre-Clovis hunting in the area—a proposal based on the presence of two long ovate points that are postulated to be older than Clovis.

A sharpening flake was probably struck off a heavy chopper, which needed to be reworked and which could have been used for either wood shaping or butch-

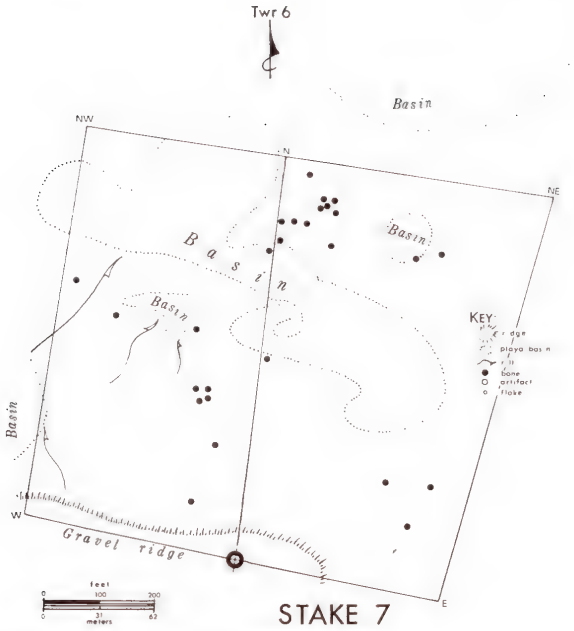


FIGURE 66B. Stake 7, distribution of bone.

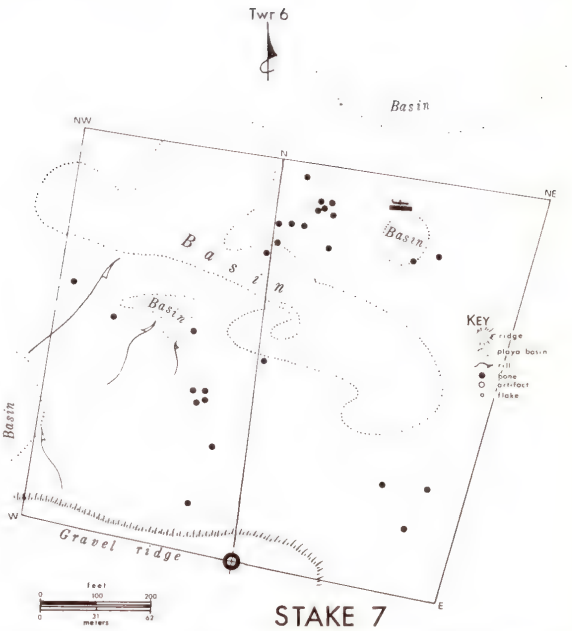


FIGURE 66D. Stake 7, location of a single Fluting Co-tradition knife/point.

FIGURE 66C. Stake 7, distribution of beaks (curved arrows).

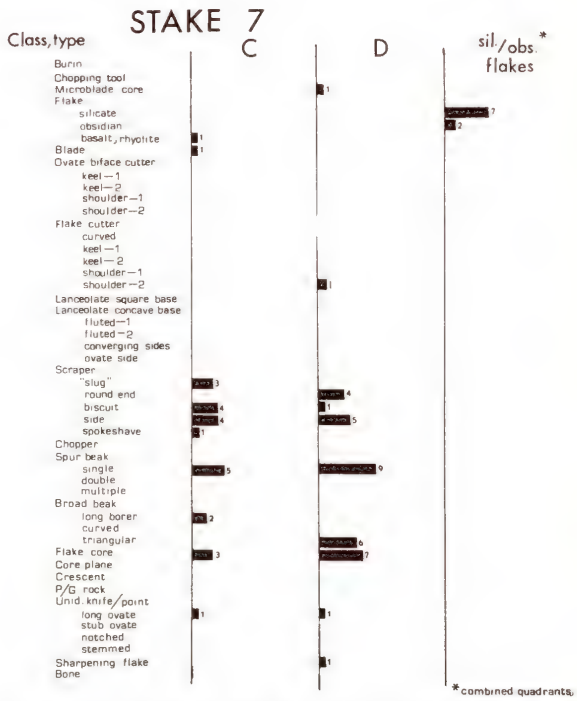


FIGURE 66E. Histogram of Stake 7 artifact frequencies.

ering. Association of beaks and bones has already been mentioned—perhaps the Stake 7 locality was a place where older bone could be found and salvaged for the manufacture of equipment. The numerous scrapers also identify this as a processing locality.

Paleocultural affiliation.—The only clear tie is with some subphase of the Fluting Co-tradition series. Otherwise, this somewhat disturbed inventory of weather-beaten tool scraps is uninformative at present. Stake 7 is one of several activity areas that would benefit by restudy of the tools when attribute analyses are undertaken.

Artifacts and discussion.—The artifact histogram (Fig. 66E) contains another interesting bit of information—with the exception of two obsidian flakes, all stone tools were made of silicate or volcanic rock. Not noted in the histogram is the fact that we observed some of the tools to be extremely weathered.

Only two obsidian flakes were collected in Quadrant C and none in Quadrant D—the other flakes were chert (2) and chalcedony (7). The flake cores were unusually tiny, although small cores are, in general, characteristic of Lake China industries since stone was at a premium. In addition, there are so many microflakes on these sites that one is led to suspect the use of compound tools (such as coarse saws) in which the microflakes were cemented into a handle of wood or rib.

A careful study should be made of the Lake China cores of all sizes, since large ones intergrade with both planes and Levallois cores, whereas some of the smaller ones intergrade with biscuit scrapers.

Stake 8

Elevation of datum.—2,178 feet MSL.

Situation.—This survey area consists of quadrants A, B, C and D. Like Stake 7, it is located on the southeastern periphery of the Intensive Test Area and evidently occupies what was at times a terrain of low relief near a shore of the lake. It is important to remember that this lake was fluctuating, with many ephemeral stands. Lake levels controlled the availability and desirability of various localities for use by PaleoIndian foragers.

As an example, when the bay at Basalt Ridge was a useful locality, Stake 8 was probably under 30 feet of water. When Stake 8 knoll and shores were a prime spot for foraging or an occasional kill, the Basalt Ridge locality was bone dry and doubtless abandoned.

Surface deposits.—The datum pin is in the middle of a long knoll covered with virtually sterile sand. Relations of the sands, soils (which bear cultural materials) and substrata are shown near the end of this report in Fig. 93: Comparative Geochronology of

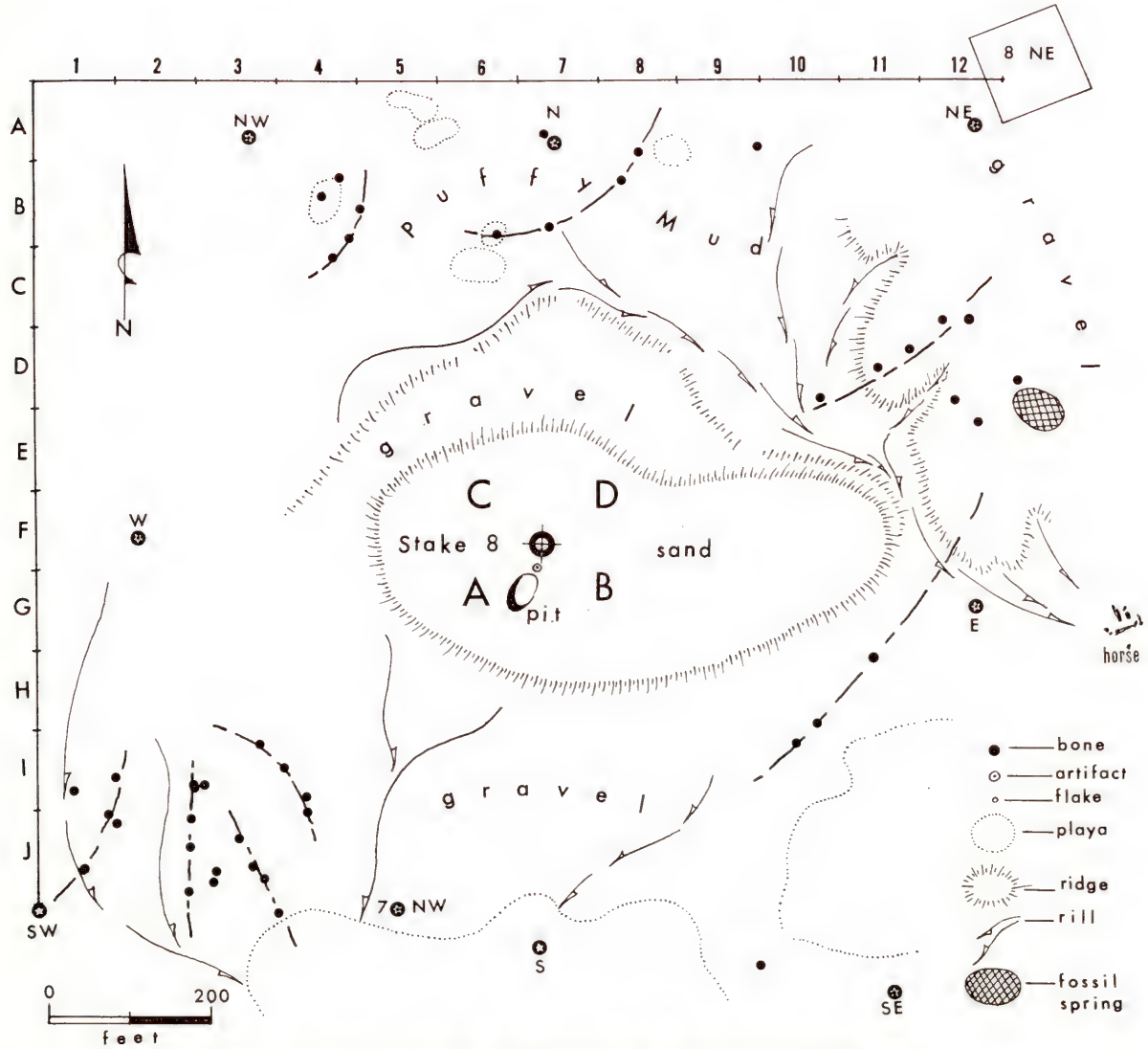


FIGURE 67A. Map of Stake 8, showing physiography, distribution of bone and location of Stake 8NE.

five lakes. These lakes are Lake China, Lake Lahontan, Lake Searles, Lake Tulare and Lake Mojave. It is unfortunate that when the latter was tested by Ore and Warren (1971) they did not include observations of soils in their report.

PALEOSOLS ARE THE KEYS TO PALEOINDIAN HABITATION IN THESE PLEISTOCENE LAKE VALLEYS.

To return to Stake 8, sterility of sandy mantles is expected since these materials are remnants of two lacustrine layers covering habitation sites of two different ages: one, later sites on a weak soil that separates the two sandy levels; and the other, earlier site groups on a strong soil underlying *both* sands.

Extensive and deep erosion is taking place on all sides of Stake 8 knoll, particularly along its northern periphery where rill action is incising older lacustrine clays, visible as patches of "puffy mud." New systems of active gullies are shown as arrows in Fig. 67A. In the southwest corner of the stake, these intersect older rill scars, traceable by linear deposits of bone fragments washed down from above. This locus is defined by coordinates H-J/1-4.

The knoll is surrounded by a bench of coarse, dense gravel, possibly a remnant of the strong soil mentioned above. Scattered artifacts and a camp concentration are erosionally exposed between coordinates G-1/9-12 (Fig. 67B). There are numerous scatters of "flaggy sandstone" around this stake. They were originally labelled "fossil spring," which is a misnomer. At that time we did not know that these little piles of duricrust were remains of paleosols, a discovery that has been of major importance in this paleo detective story. A line of flaggy sandstone mounds runs northward from Stake 8 into Stake 8NE. It will be important to excavate within 8NE to determine whether the flakes

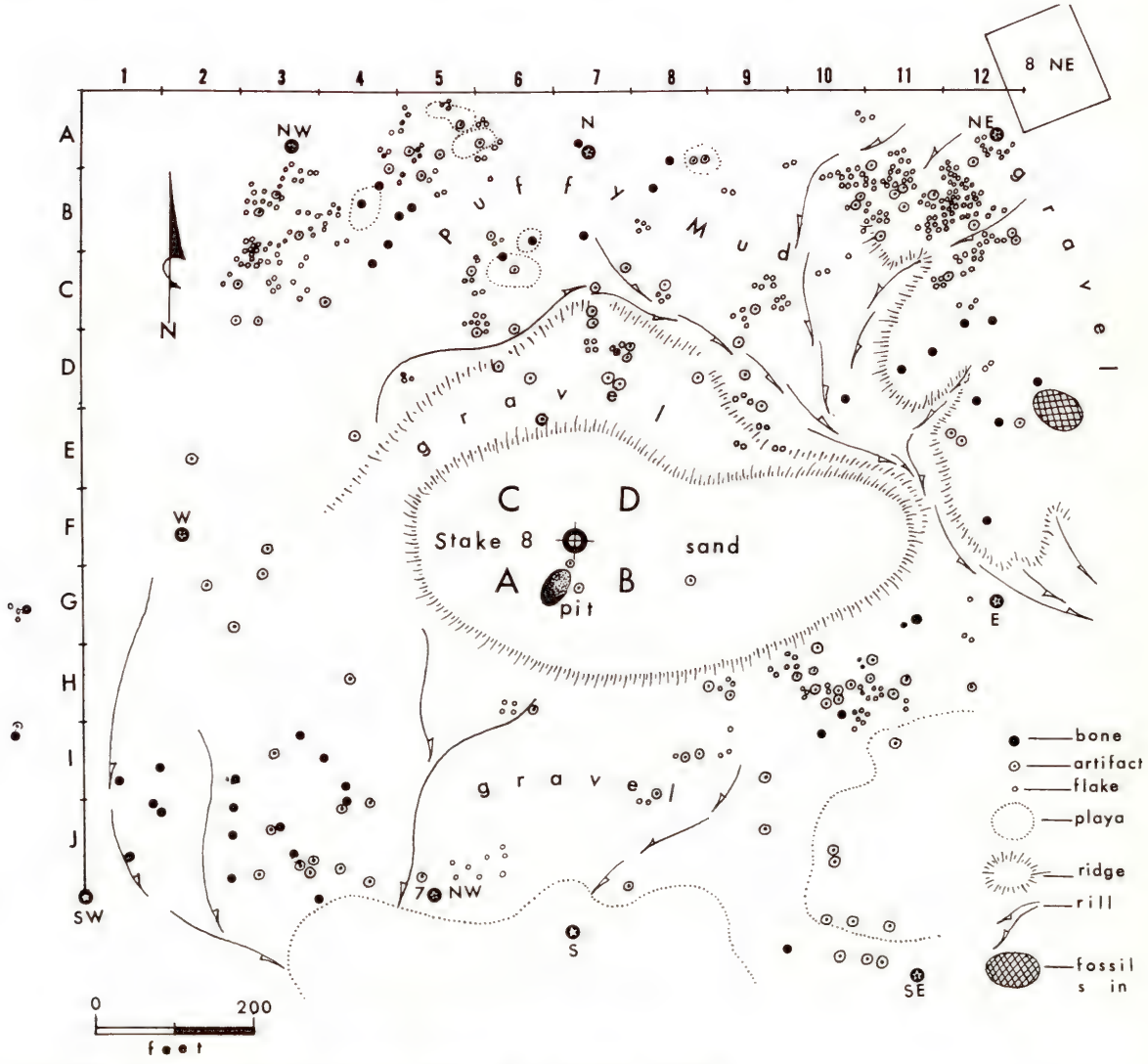


FIGURE 67B. Stake 8, distributions of artifacts, flakes, bone and flaggy sandstone.

and bones weathering out of its strata originate within, above or below the paleosols.

Fauna.—By far the best horse remains found to date were partially exposed on fluviatile layers near the E corner of Quadrant B. This partial skeleton of a juvenile animal lay on top of thin deposits of lacustrine clays and sorted gravel and were embedded in a sand and gravel matrix. Only the hind limbs and fragments of pelvis and jaw were found. However, for a Lake China specimen, the lower legs were in fair condition whereas the astragali, calcanei and distal phalanges were remarkably well preserved and epiphyses are clearly visible on the calcanei. An arrow points to one hoof in articular position (Fig. 67C).

Good preservation and relatively undisturbed positions of the posterior parts of this animal contrast sharply with complete lack of all anterior parts except the fragment of jaw and teeth. These, together with a white chert flake were pointed backward near the pelvis—a relation that suggests PaleoIndian butchering activity after the foal had died half in and half out of the mud. An investiture of clay preserved its hindquarters but the forequarters were either carried away or destroyed by exposure.

Bone fragments in the SW corner of Quadrant A are associated with identifiable members of the following:

Taxon	*No. of identifiable members*
Mammuthus sp.	2
Equus sp.	4
Camelops sp.	8
Bison sp.	8

Cultural activities.—Little about human activities can be inferred from flake/artifact distribution in the NW and NE corners of the stake. These sectors of quadrants C and D have been attacked by erosion and the artifacts are scattered. However, the gravel benches surrounding Stake 8 are relatively intact and the artifacts they support are, therefore, less disturbed. The benches are remains of a strong paleosol that appears repeatedly throughout these sites. Artifacts lying on them around Stake 8 knoll are of interest since they present the appearance of a camp centered at G-H/10-11; another camp at C-E/6-8; possible traces of a male activity locus at F-G/2-3; and a women's work area at H-J/3-6. These are suggested as female activities because

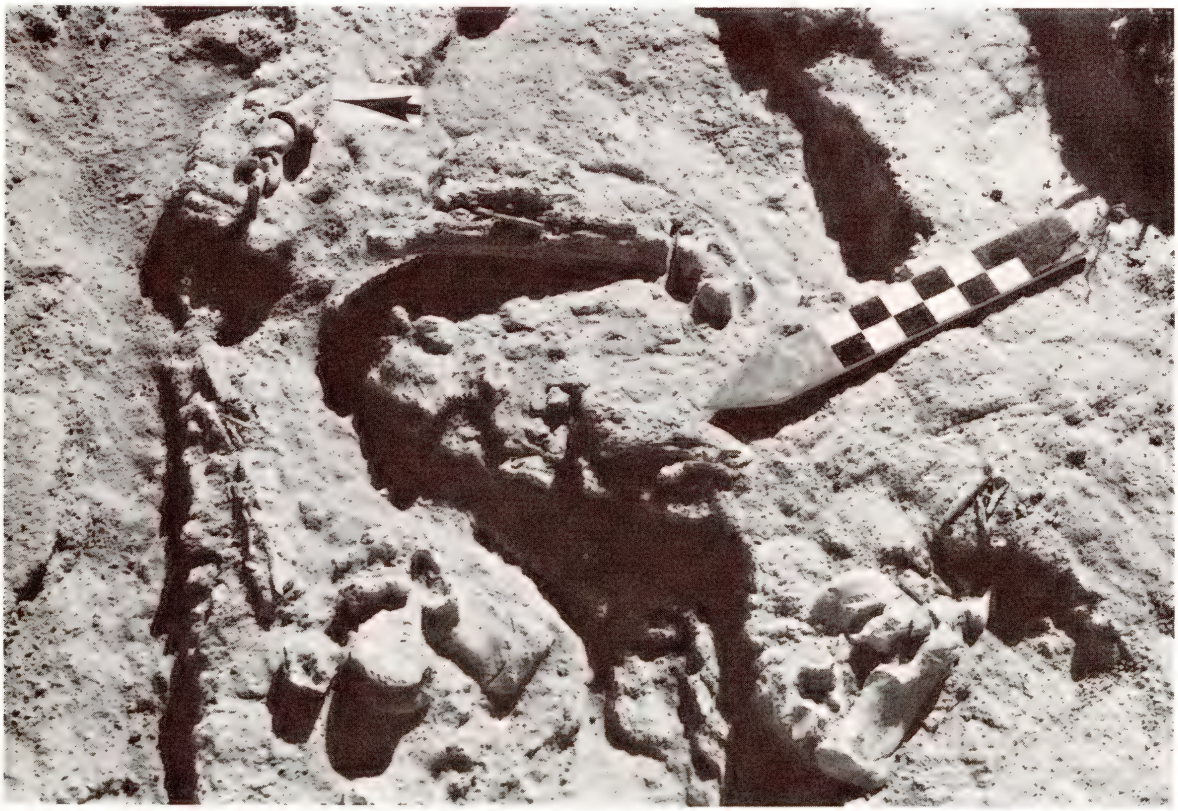


FIGURE 67C. Photograph of horse remains, east edge of Stake 8. Arrow points to left hind hoof.

there are no male tools such as knife/points or crescents in the toolkit. Work was probably devoted to peeling and trimming willow or apocynum and performing various small-tool operations with finger held implements. A single beak points to scribing or incising of such hard material as bone that may have been weathering out of older deposits.

These camps and work loci were evidently bases for general foraging, manufacture, a little hunting and butchering of large animals, and a few episodes of a hunter's returning from birding.

Dates.—No ^{14}C measurements are available for this locus. An estimate is that it was used (rarely and by small bands) between about 15,000 and 8,000 years BC.

Paleocultural affiliations.—The picture of these is not clear—for one thing, Stake 8 materials were scanned and arrayed early in the study, before we began to suspect that a long sequence of cultural horizons with surprising time depths were to be found in the Lake China basin. Therefore, we were not on the lookout for differences in weathering, technology and tool classes, which later became routine observations.

In general, the toolkits appear to represent Proto-Clovis of Lanceolate Tradition: Lake Mojave (or a Lake Mojave mode of early Clovis); and Classic Clovis Phase. When these collections are more knowledgeably reviewed and more detailed separations have been made then more clearly defined phase differences should appear.

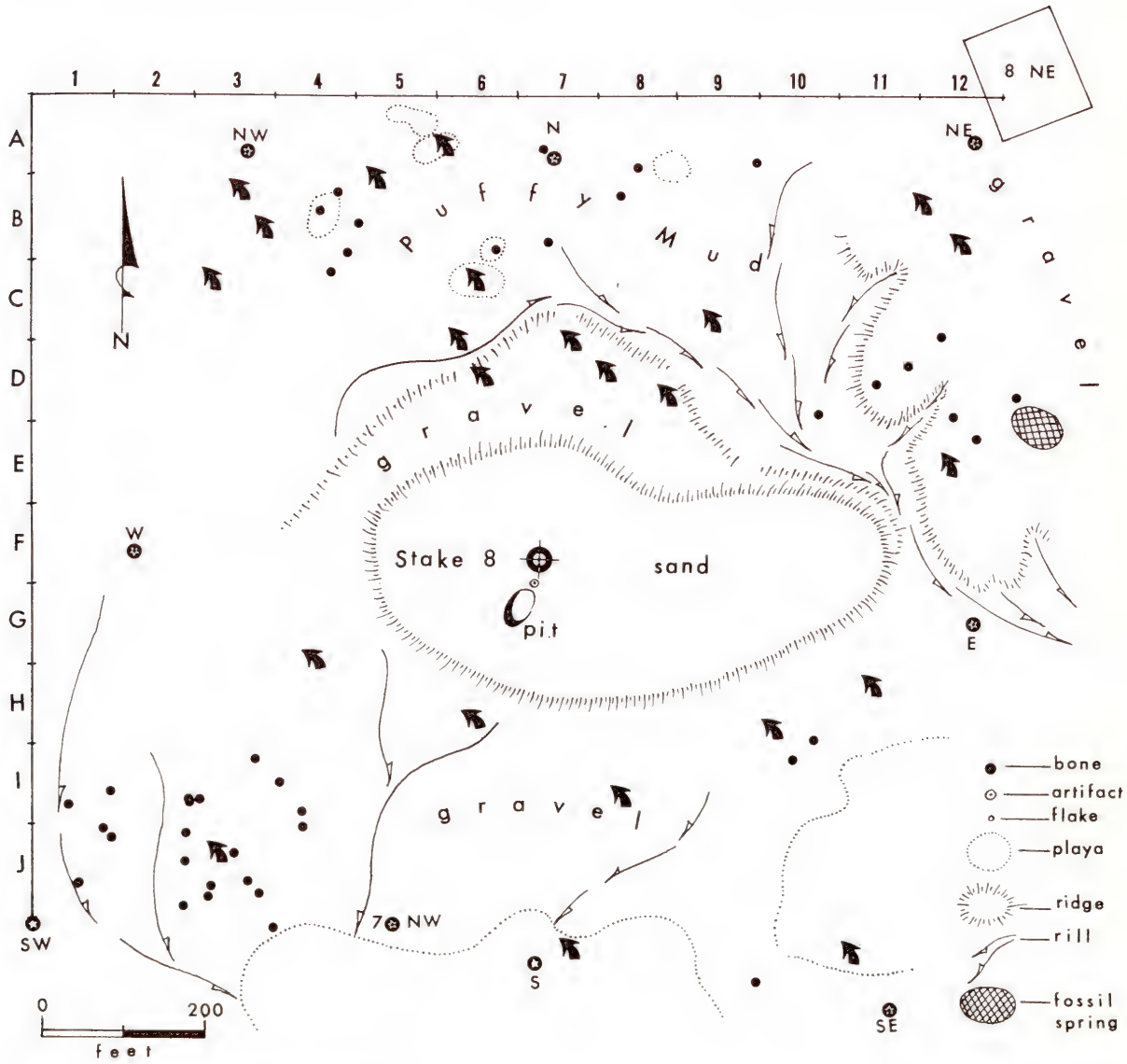


FIGURE 67D. Stake 8, distribution of beaks.

Artifacts and discussion.—Stone tools are distinctively different in the four Quadrants as follows: Quadrant A, women's work area implements are frequently composite in function, and are generally suited to small tasks connected with sawing, scraping, piercing and sizing of withes and shoots (basketry?). These tools are small—some of them remarkably small indicating the delicate performance of fine work.

Discovery of such refinement and artistry at pre-Clovis levels is of great importance for our appreciation of early New World people and their skills. Two of the women's saws can be classed as tiny, barely large enough to grip with thumb and forefinger. Most of these tools are made of silicate rock; they are carefully fashioned; and all have been shaped from irregular flakes.

Quadrant B artifacts are entirely of silicates and resemble the assemblage of Quadrant A, including several saws and spokeshaves, two of the latter being exceptionally small.

Quadrants C and D assemblages present a very different appearance from those on A and B. C toolkits are made of chalcedony, a quantity of grey chert, and some new-looking quartzite. Two and possibly three cultural horizons, judging both by chemical and physical weathering on the stones, have contributed to the medley of battered rock on the present surfaces of C: an older horizon left by people who had come in from

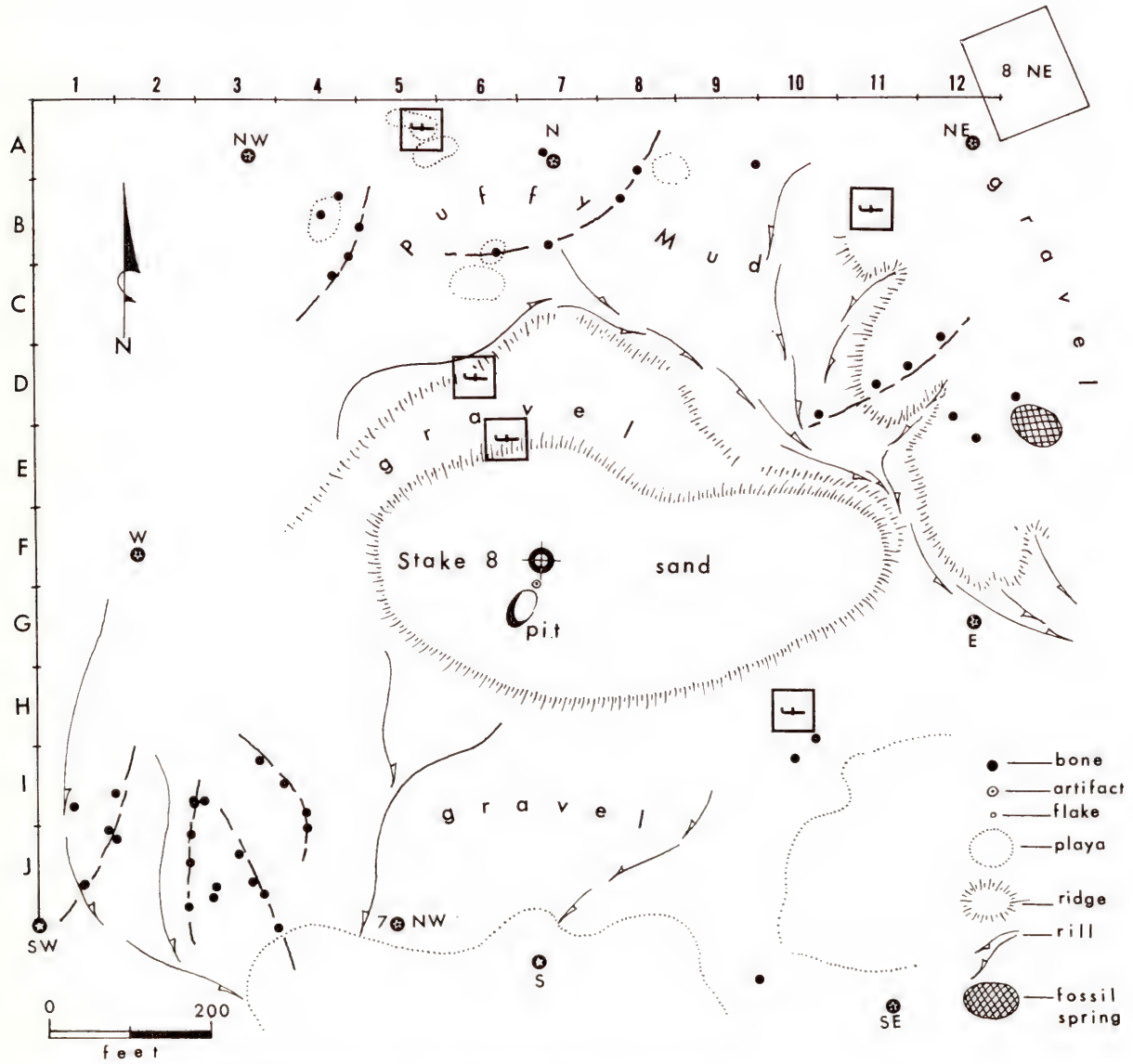


FIGURE 67E. Stake 8, distribution of Fluting Co-tradition knife/points ("fs" in boxes).

the south through the El Paso Mountains; and a later visit by foragers whose last port of call had been somewhere to the north, probably the Inyo Mountains. We shall have much better control of directions of these foraging cycles after a study of sources and composition of artifactual rocks has been completed.

The quartzite component in Quadrant C might either be associated with the chert or represent a still later occupance of the locality. Quadrant C mixed assemblages also contained four blades—a high score for these Lake China localities. It is probable that intentional blade fabrication did not appear until after 10,000 years BC, followed by introduction of microblade manufacture (in very limited quantities) after 8,000 years BC. These estimates are based on careful observations but have not been tested by a review of this and other collections.

Quadrant D scatters contained five blades. There is also a copious outwash of flakes from eroding sites in the vicinity of Stake 8NE (probably a two-horizon locus with relatively late upper components). Combination tools are common in Quadrant D as they are within a number of other stakes. Implements of this kind are assumed to indicate manufacture of gear and camp work of many kinds, particularly those more delicate tasks that are frequently specialties of women.

The large number of beaks shown in Fig. 67D indicates that various kinds of work involving piercing

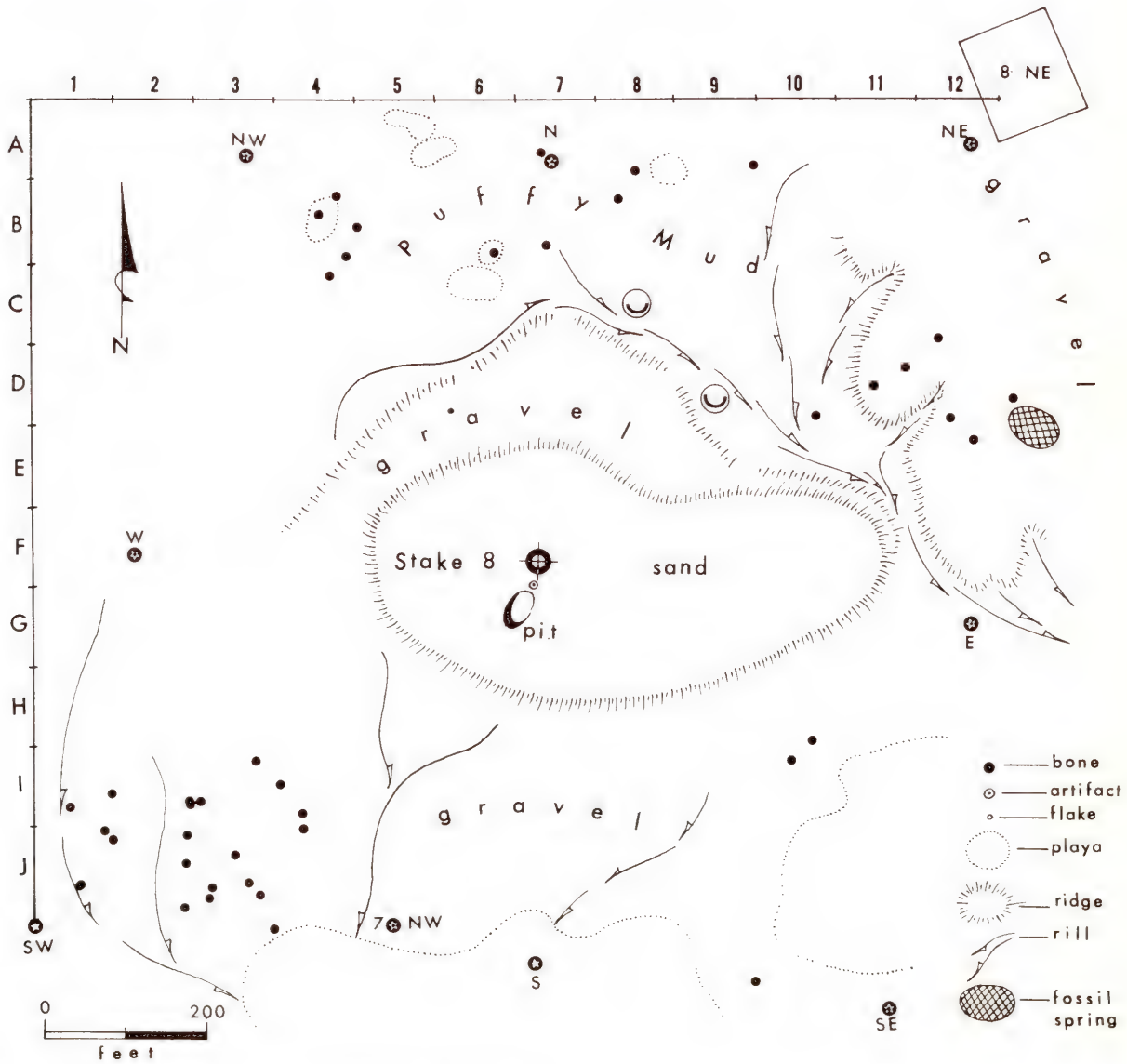


FIGURE 67F. Stake 8, distribution of crescents (arcs in circles).

and scribing were universally performed. Beaks are ubiquitous on all later sites in this valley—beaks *qua* beaks; beaks on cores; beaks on saws or scrapers. There are even beaks on the objects "lumped" as "Lake Mojave Points."

Presence of persons doing camp work during the Classic Clovis Phase is documented by a single, unmistakable object—a side-scraper/saw combination instrument that is exquisitely flaked and made of heat treated chalcedony. It is a remarkable match for a Classic Clovis rounded end-scraper that was mapped in Site Area 1 at the Basalt Ridge.

Fluted knife/points are shown in Fig. 67E. Those on the gravel benches are probably close to their original positions, whereas those in erosional zones may have undergone considerable transport. Two crescents are shown in Fig. 67F. They may have once lain on the bench. Fig. 67G shows a group of 'Lake Mojave Points' a soubriquet for everything from cutters and bunts to unmistakable knife/points. They are characterized by several distinctive technologies and a number of different patterns and functions.

Fig. 67H shows histograms of the four quadrangles. The graphs contain a number of expectable disconformities when compared with the maps on one hand and the edge-punched cards on the other. This discrepancy is unfortunate. However, considering how much we learned during the first five years of this work, it is surprising that correspondences between the various kinds of records have turned out relatively well.

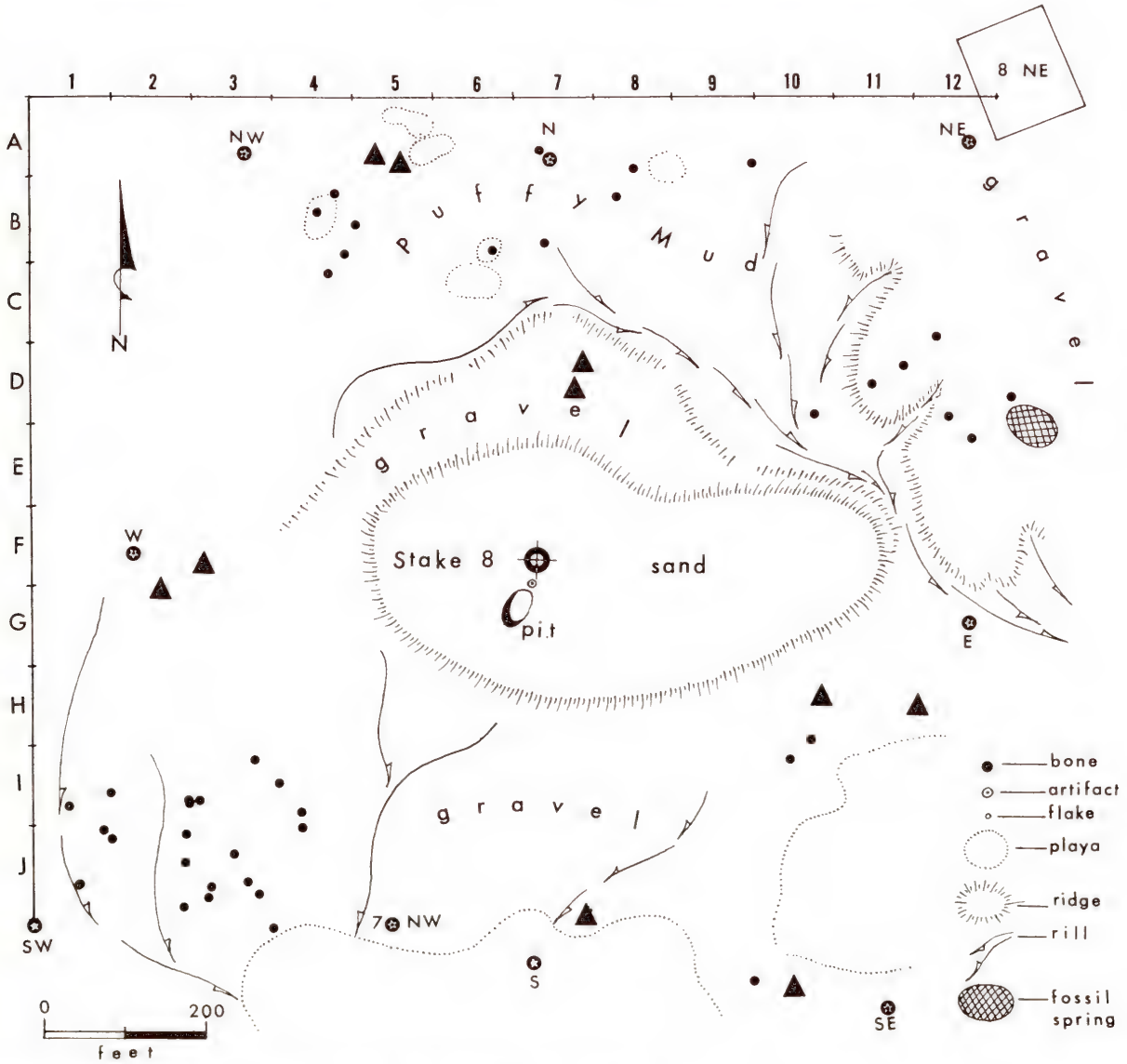


FIGURE 67G. Stake 8, distribution of objects classifiable as "Lake Mojave."

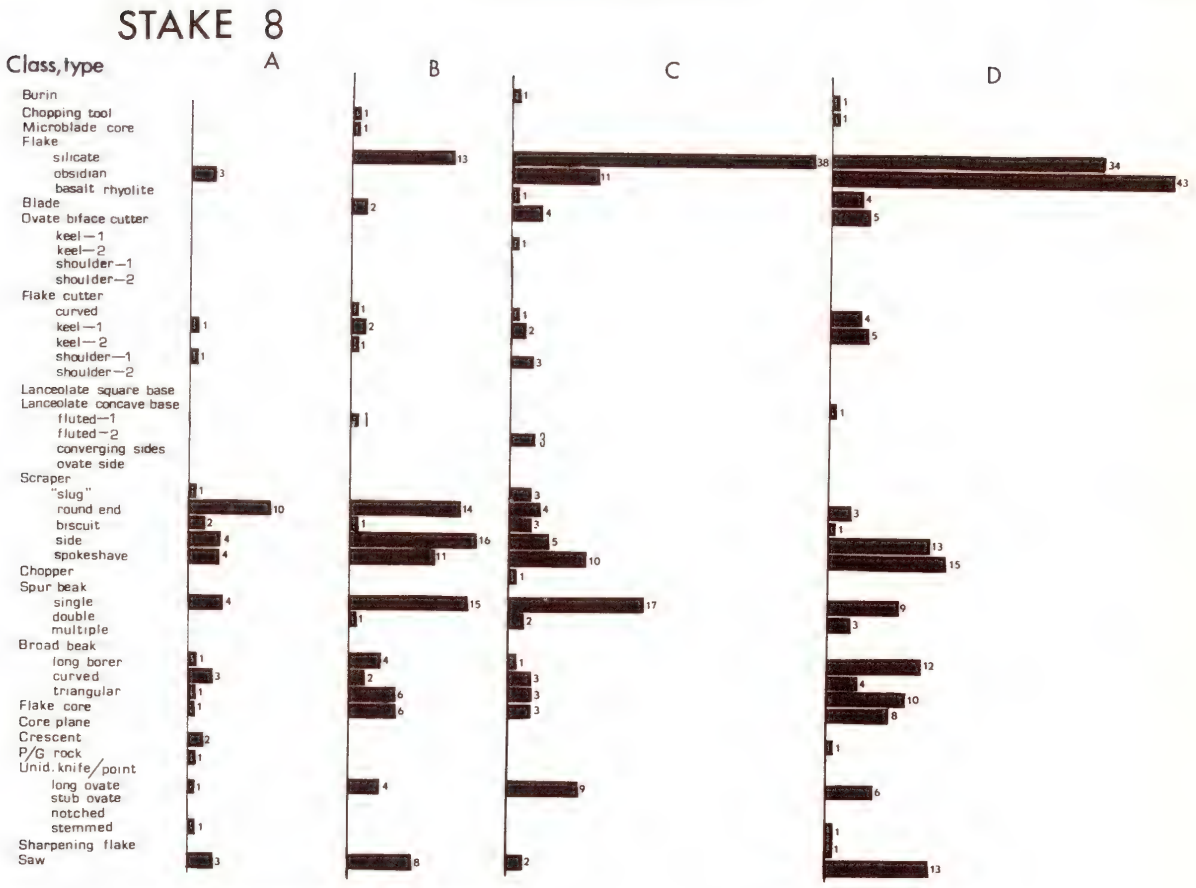


FIGURE 67H. Stake 8, histograms of artifact distributions.

STAKE 8NE

This small, test stake was established as an extension of Stake 8; it was outside the area but appeared too rich and informative to be neglected. A datum was set arbitrarily in the midst of a wide flake scatter and two reference lines were laid out N-S and E-W, defining a work area measuring 200 × 150 feet. Steel bars marked each coordinate into 25 foot lengths, which in turn were sub-divided into 5 foot sections by driving orange-flagged nails into the ground (Fig. 68A). A Brunton Pocket Transit on an aluminum stand and graph paper were used in mapping.

Methods of work.—Every flake and bone scrap was included in the final diagram. First each quadrant was searched methodically on hands and knees, marking stone and bone with flagging tape on a nail. Then the Brunton on its tripod was placed over each specimen which was then located by shooting in markers on the two coordinates. This check point on the graph paper was given a number in sequence; the same number was written on the object and noted again with a classification (knife, scraper etc.) on a tally sheet.

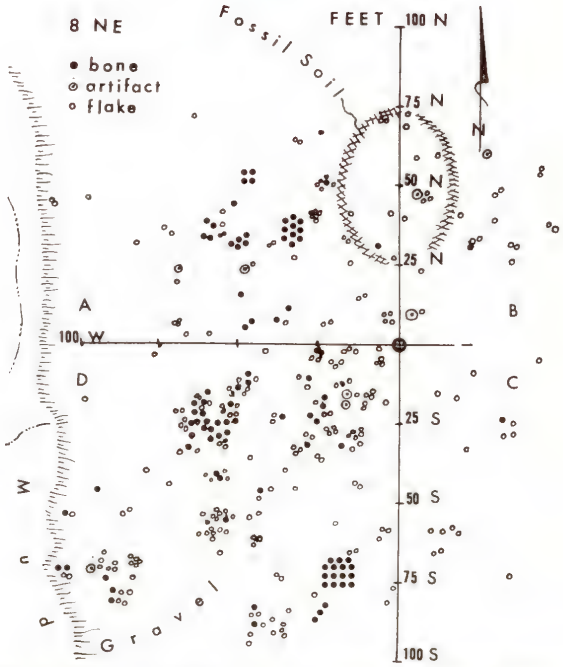


FIGURE 68A. Stake 8NE, general scatter of bones, artifacts and flakes.

Elevation of datum.—2,164 feet MSL.

Situation.—The western two-thirds of this site locus is on an eroding surface of gravel. This surface probably supported a paleosol with which most of the bone had been associated, but the locality should be revisited and restudied before this relationship becomes clear. Just east of the N-S coordinate there is a rather high knoll, covered with loose sand. Along the western edge of 8NE, erosion becomes more strongly marked and numerous rills feed into the deeply incised basin of Stake 8, Quadrant D.

Surface deposits.—Stake 8NE appears to have the same stratigraphic relationships as most other stakes we have mapped: there is at least one (probably two) layers of loose sand on top, possibly with a weak soil separator in the middle. The sand overlies a soil of which unusually strong remnants appear within this locality. Most artifacts and bone were on or in this soil but there is also a likelihood that the higher and more easterly scatters originated in a weathering surface within the sands.

There is little doubt that cultural materials remain under these sandy deposits and a trench should be stripped out from the summit to the western edge of the camp area to find stone and bone (relatively) *in situ*.

Under the sand and a strong soil there is a coarser and more cemented lacustrine layer. This bed should cover (or contain fragments of) an older paleosol for which we are looking. Therefore, the trench should penetrate the cemented deposit down to underlying lacustrine clays. These clays evidently were laid down during a period of high water when the lake was deep enough for its bottom to be undisturbed by wind, permitting clay to be deposited under reducing conditions and accounting for the greenish color of eroding exposures.

Fauna.—A considerable amount of finely splintered bone lay scattered about in patterns that are approximated by two arcs shown in Fig. 68B. These suggest two configurations possibly associated with two former stratigraphic levels: a weak soil and a strong soil that recur in these sites. Most bone (like most artifacts) appears to have originated on the stronger soil, which is much in evidence at Stake 8NE. Both animal remains and human detritus lie along the left hand arc, about 50 feet west of datum. Associated with this same arcuate disposition there were also bases of two fluted knife/points (shown as circled "fs") and a fragment of camelid skull.

It is possible that a lesser amount of bone scrap, and fewer artifacts (conforming roughly to the right hand arc), were derived from a weak, upper soil that we failed to recognize at that time. The skull fragment mentioned above was the only identifiable bone on this stake, limiting the faunal count as follows:

Taxon	No. Represented
Tanupolama (?)	1

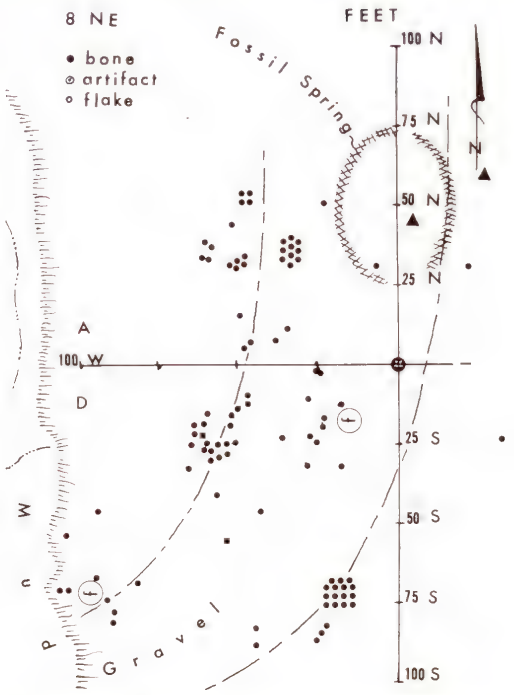


FIGURE 68B. Stake 8NE, distributions of Fluting Co-tradition knife/points (circled "fs") and stemmed objects (black triangles).

Establishing associations of the Rancholabrean fauna on these sites with the people who camped and worked there is one of the major goals of our research. Therefore, the Stake 8NE, Quadrant A camelid is a valuable piece of evidence—it is unquestionably a part of the Clovis horizon, because both camel and diagnostic artifacts are associated with the same paleosol.

Cultural activities.—This was a general camping and camp-work locality in a relatively sheltered spot, which had the advantage of being between a large pond and a shore of the lake. The various campers killed small or young animals when opportunity presented, did a lot of slicing and slitting either when making jerky out of the meat of their kills, or trimming their dressed hides for clothing and equipment. No birding was done with crescents. Perhaps they were snared or netted. They did not leave tools which could reasonably be connected with shaping harder materials like bone or large pieces of wood (broad beaks of all patterns and spur beaks—see Fig. 68C). However, the four spokeshaves in Quadrant D suggest peeling and trimming of small splints.

Paleocultural affiliations.—There were two periods of habitation here. A lower one belonging in a Pre-Classic Clovis horizon, associated with a strong paleosol and considerable finely broken bone. The second horizon which is higher, and therefore later, is associated with a hypothetical upper soil and also with two obsidian artifacts attributable to Lake Mojave cultural pursuits.

Dates.—No samples for radiocarbon dating were

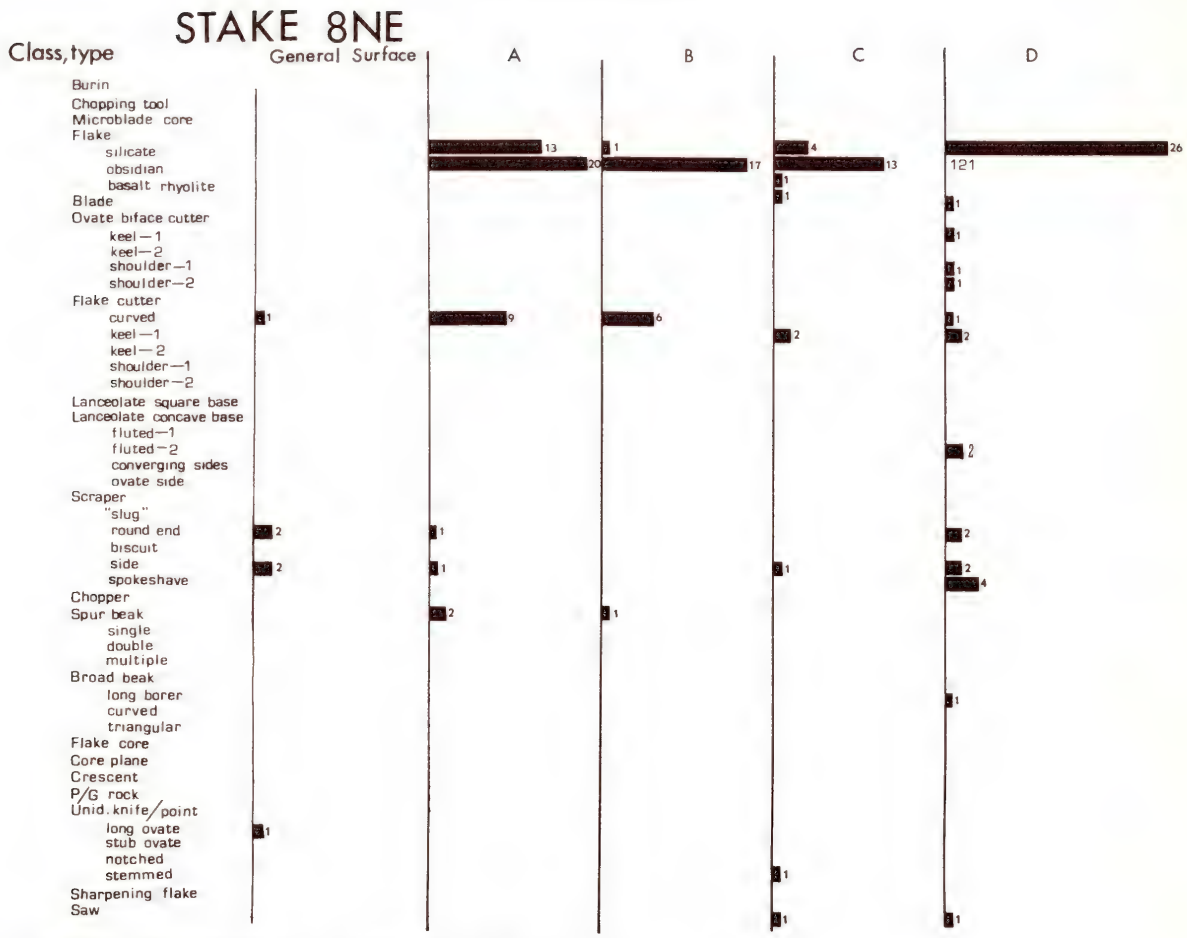


FIGURE 68C. Stake 8NE, histograms of flake and artifact numbers.

taken from this site locus. However, when fieldwork is resumed and Stake 8NE is trenched, it should be possible to date the culture-bearing soil or soils.

Artifacts and discussion.—Recognizable tools are scarce by comparison with the number of flakes, possibly because the main part of the living floor is still safely buried underneath mantles of sand on the ridge.

The people who used this locality worked with obsidian more than silicate rock. Making and sharpening artifacts seems to have been more important than other tasks as we are now able to recognize them. However, further work in the locus may drastically revise this interpretation.

STAKE 9

Elevation of datum.—2,183 feet MSL.

Situation.—The datum stake is in the middle of a steep mound of loose, lacustrine sand, which mantles a ridge of coarser, cemented gravel (also lacustrine in origin). This gravel probably supports remnants of a strong soil—as it does at other stakes—and this soil once contained a major proportion of the eroding artifacts.

A relatively elevated saddle just east of the sandy mound is probably a more deeply eroded exposure of the same gravel stratum. This gravel attenuates northward and southward into areas where lower strata have been penetrated and little silt playas have formed (see Figs. 69A and B). A particularly large basin of this sort can be seen in the southwest quadrant of Stake 9.

It is interesting that these silt-filled hollows are generally as sterile of artifacts as the loose sands and for the same reason—if artifacts were ever here, they have since been covered *and most of them remain so.*

Surface deposits.—These follow a familiar sequence, extending from the surface downward as follows. The uppermost sand is loose and only medium-coarse. It probably has two distinguishable layers separated by a weathering surface and a weak soil. This soil might have contained a few, late artifacts (6,000 BP). Under the sands there should be a well-developed soil representing a long period of stability at this locus. During this period, hunter-forager bands camped here on rare occasions.

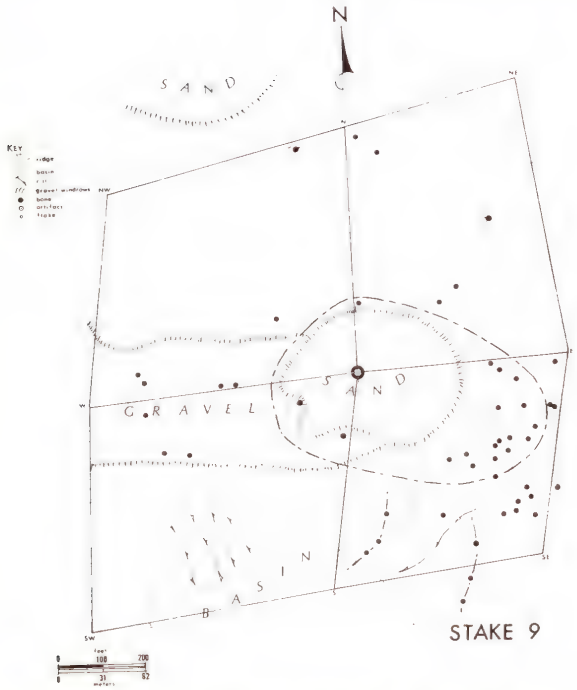


FIGURE 69A. Stake 9, showing landscape features and distribution of bone. Broken line around station center suggests possibly related specimens.

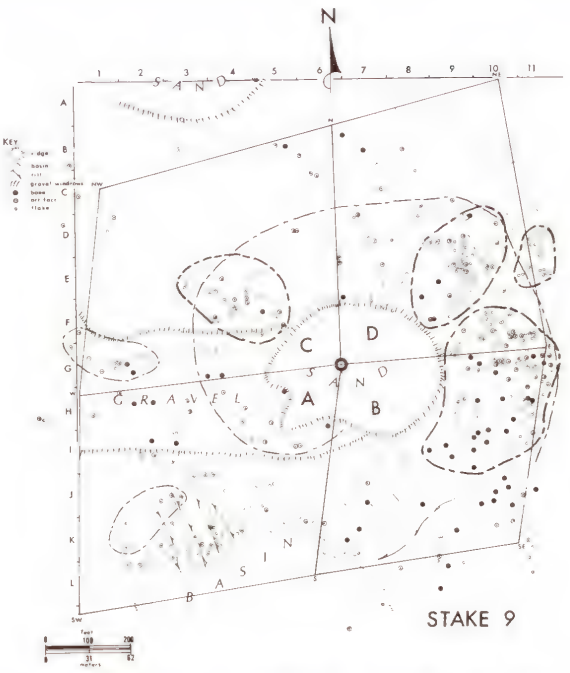


FIGURE 69B. Stake 9, distribution of artifacts and flakes. Broken lines suggest possibly related sub-groups.

A third soil (still relatively unknown) and lacustrine clays should underlie the cemented bed. An interesting surface feature can be seen in the middle of Quadrant B: gravel covered windrows of silt, common in this area of the valley. The etiology of such parallel ridges is not known, but they are always normal to the prevailing wind direction. Note that in this locality they run parallel to a series of recent rills in Quadrant A. Possibly the windrow troughs furnished channels in which the rills got started.

Fauna.—Most bone on the surfaces of this stake appears to have originated on or in the strong soil (the weaker soil has not been identified at this locus). Correlations are poor between individual bones and taxonomic identifications made later. The head-count of animals recorded on edge-punched cards (made out in the field) is approximately as follows.

Taxon	*Probable number of individuals*
Mamuthus sp	2
Equus sp	3 (?)
Camelops sp	14 (?)
Bison sp	2

Both bone and artifacts immediately encircling the Stake 9 mound of sand could only have been associated with the strong soil that once supported them. *Therefore, there is no doubt that these bones were linked with activities of those people who occasionally camped here.* Associations of PaleoIndians and Rancholabrean prey animals frequently are indeterminate on these sites, but at Stake 9 they seem clear.

Cultural activities.—The various PaleoIndians who used this locality seem to have done their hunting and marshland foraging elsewhere, bringing foods, raw materials and parts of animals (mostly camels) back to the Stake 9 home bases, to be used or consumed at leisure. Stake 9 has an additional support for the proposed associations of people and extinct herbivores—namely the large number of beaks for scribing or grooving (Fig. 69C) within the circumference of site clusters. These were work sites, where manufacture and preparation took place, and where tools were made or resharpened. Two saws (not recorded in the histograms) are clues to possible woodworking. These specimens should be re-examined for tooth size, because if the teeth are long and somewhat irregular, the implements may have been shredders for roots and plant foods. Both the saws were in the site clusters of Quadrant D, indicating women's work area or family camps where certain tasks may have been assigned according to sex.

Paleocultural affiliations.—The first observable use of this locality took place during the Proto-Clovis Phase, represented by a fluted, single-shouldered knife/point of early Lanceolate Tradition (specimen 19D-19). No Classic Clovis or Degenerate Clovis tools were found on the Stake 9 surfaces, but there were a few implements attributable to a Lake Mojave connection—or mode, perhaps, of the basic culture (see Fig. 69D).

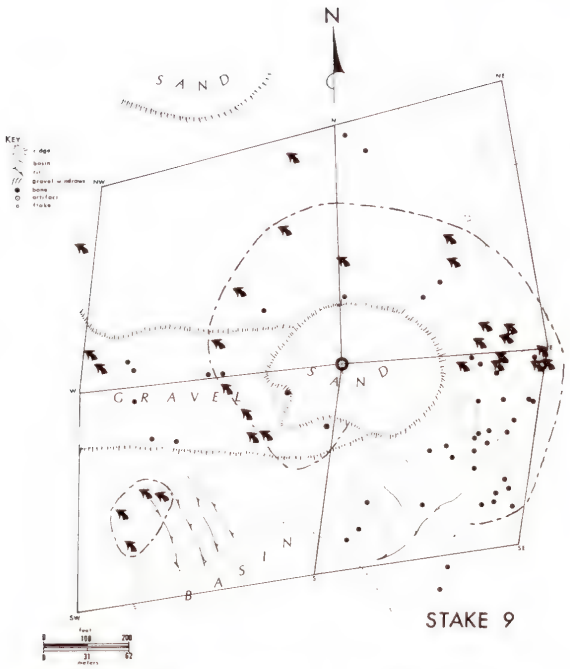


FIGURE 69C. Stake 9, distribution of all beaks.

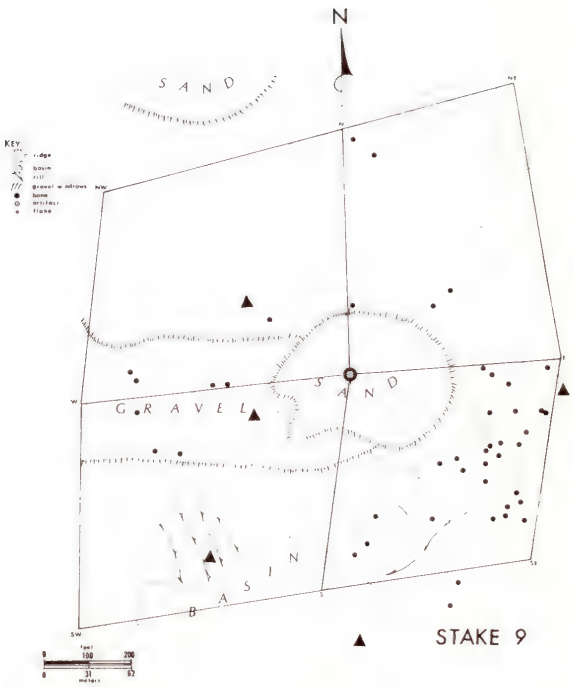


FIGURE 69D. Stake 9, distribution of Lake Mojave (stemmed) objects.

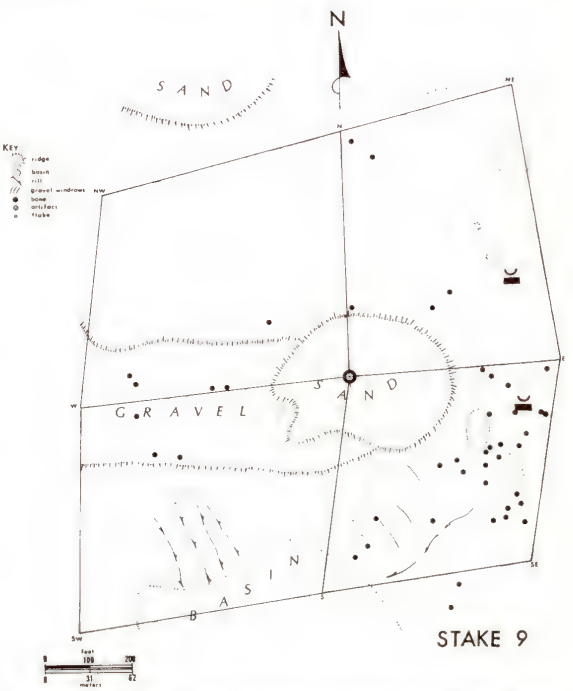


FIGURE 69E. Stake 9, distribution of crescents (inverted arc and bar).

We are unsure of the relationship between Lake Mojave (derived from ovate-shaped implements of the Western Lithic Co-tradition) and Clovis. When technological analyses of these two weapon styles have been made (and such analyses are next on the agenda), we will know more about technological similarities and differences of the two categories. *Clovis and Lake Mojave may be different job-specialization tools out of the same toolbox.*

We are inclined to view these Mojave Desert Paleo-Indians (at any particular moment in their history) as sharing versions of a single culture even though various bands across this huge countryside may have spoken different dialects or even different languages. In such circumstances the situation would have been somewhat analogous to that prevailing in the present-day Southwest.

Dates.—No radiocarbon dates are available for this locality.

Artifacts and discussion.—Cores from this stake had been used until they could no longer be held securely. They also seem to have been used to produce very small flakes—so small they would have required hafting. This raises an interesting possibility that early people (in this stoneless environment of the valley floor) were extremely thrifty and salvaged even tiny flakes by hafting them into wood or rib.

No fluted implements later than Proto-Clovis were found. However, excavation beneath the sandy mantle of Stake 9 might disclose a Clovis occupancy of this knoll. The amount of Rainbow Ridge stone found on these sites was unusually large, indicating that some of the campers who visited here had come in from the south through the Rademacher Hills.

Crescents were scarce, and only three fragmentary ones were found. Two of these were recognized in the field and were recorded on the edge-punched cards,

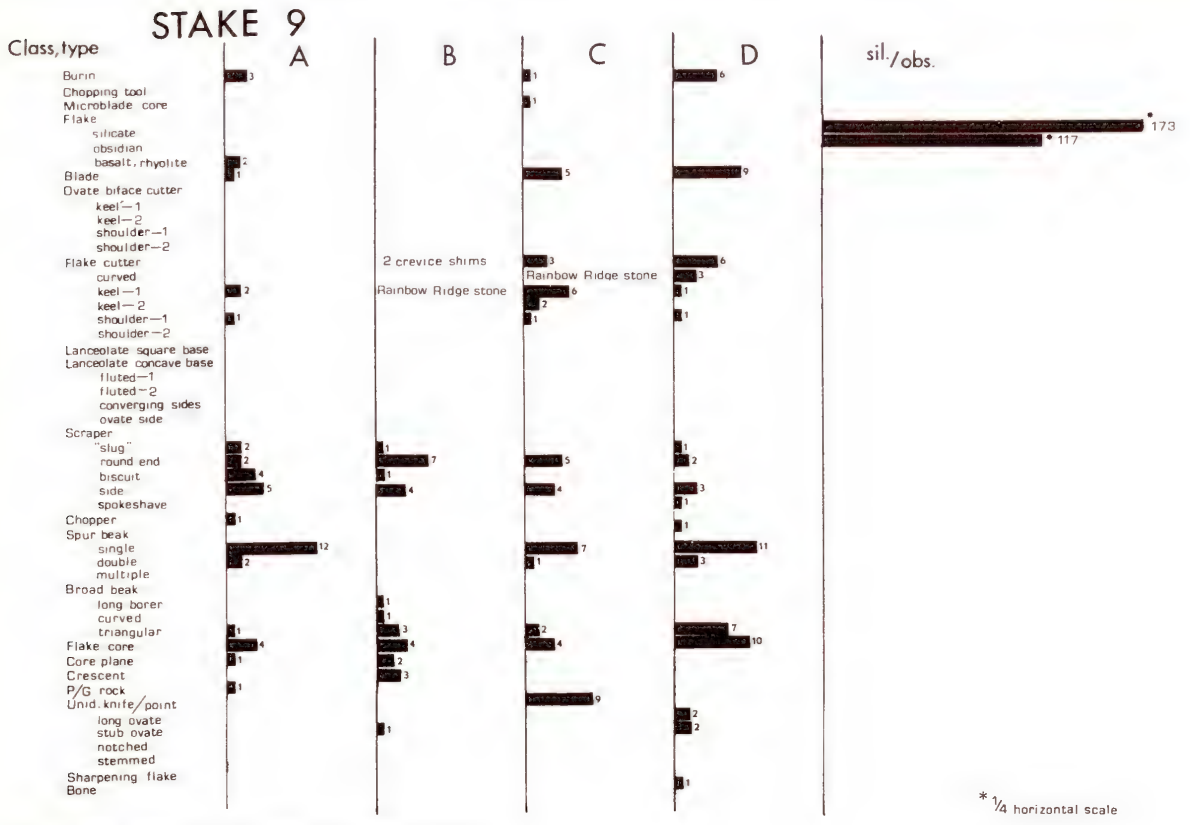


FIGURE 69F. Stake 9, histograms of artifact contents.

which were the basis for the distribution map shown in Fig. 69E. The third was identified during the artifact scan and appears in Quadrant B of the stake histogram shown in Fig. 69F.

STAKE 10

Stake 10 is different from most of the other surveyed localities with a possible exception of Stake 9 (its neighbor to the southeast). Both these stakes had unusual quantities of a beautifully mottled chalcedony found only at Rainbow Ridge. This selection of an exceptional stone tells us something about the preferences and also the seasonal migration routes of some of the Paleo-Indian campers who chose to tarry in this ridge and basin locality—they came in from the southern lakes.

Elevation of datum.—2,178 feet MSL.

Situation.—The datum stake is on a low, northwest-southeast trending ridge of gravel, with lower basins to the northeast and southwest (Fig. 70A). The highest surfaces in Stake 10 are on a knoll of lacustrine sand covering a residual landform in the southeast corner of Quadrant B. Extrapolating from Stake 1, we assume that these sands still mask a relatively intact site, an

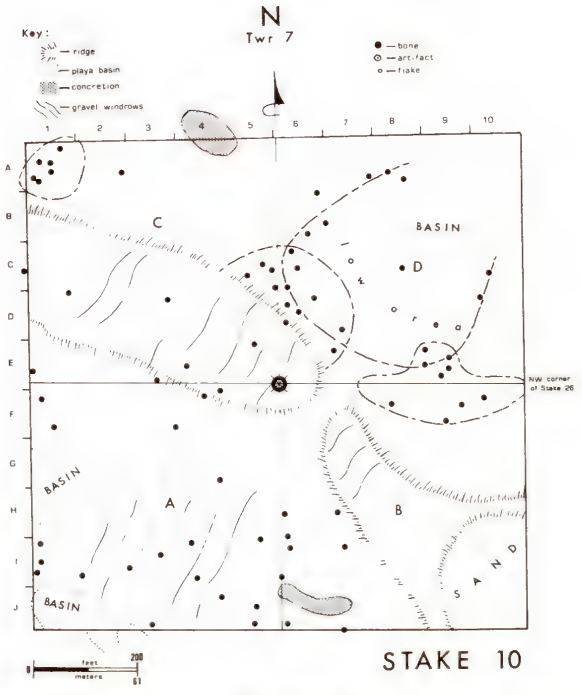


FIGURE 70A. Stake 10, landscape features and distribution of bone.

edge of which is indicated by the little cluster of obsidian and chalcedony flakes bounded by coordinates 8-9/I-J. These flakes vanish suddenly at the edge of the sandy mantle, and therefore, probably continue beneath it.

Surface deposits.—Despite the low relief of this landscape, surface features include most of those that characterize this portion of Lake China basin such as gravel windrows normal to the prevailing wind; fine, sandy gravel without artifacts; coarse, reddish gravel that supports most of the cultural material; concretions of flaggy sandstone from the strong soil; and silt-filled playas onto whose surfaces flakes and artifacts are being moved by wind and water.

Fauna.—Quantities of fragments of mammal bone lie scattered in both random and non-random distributions (Fig. 70B). There is a small concentration (partly camel) in the NW corner of Quadrant C; another overlaps Quadrants C and D along a NE margin of a gravel ridge shown in Fig. 70A and a third is on the lower margin of D. These latter two clusters form part of a roughly arcuate configuration around a low area, which at times may have contained a seasonal pond or bay as an attraction. Distributions of bone in Quadrants A and B are more random and haphazard.

It appears that two or even three separate deposits of bones are weathering out and are distinguishable from each other by differences in chroma (often noted on the 5″ × 8″ field cards). This gives us a clue to another useful parameter to be recorded in future field work, and it is important to state that our mapping system of the time did not allow for noting this statistically valuable color information. Bone chroma on our sites ranges from pale tan through chocolate brown to black. *We could make use of this by using a Munsell Color booklet in the field.* It is also necessary to say that mapping and collecting of bones at Stake 10 illustrates a repeated error in our procedures—lack of close coordination between archaeologist and paleontologist.

These procedural flaws are carefully spelled out, *because the discrepancies and correctable human oversights in our work model are as valuable as the successes.*

A tentative roster of animals follows. It could have been three or four times larger, because the illustrated, edge-punched cards (made out by each rod-person in the field) often associate faunal members with articular surfaces, which could have been identified on the spot by our paleontologist. These site localities also have an occasional large piece of tooth enamel, the best identification of all.

Stake 10, Taxon	*Estimate of individuals*
Bison sp	0
Mammuthus sp	2 (?)
Camelidae	4 (?)
Equus sp	1 (?)

A restudy of Fig. 70A gives tentative support for people-animal association in the following sub-areas of Stake 10, each of which has been outlined with long/short dashes; beginning in the NW corner of Quadrant C, there are bones, artifacts and flakes in A-B/1-2; another possible association in C-E/4-7 and a third along the E-W centerline bounded by coordinates E-F/7-10.

Both bones and artifacts may predate the strong soil associated with strong, cemented gravels on these complex surfaces. This possibility, however, is confused by the likelihood that a basalt component, marked with a strong, broken line in D/4-6 seems to be washing down from the soil-bearing gravel onto a still older surface.

Cultural activities.—Most of the dry portions of this locality probably were used sporadically over many thousands of years and were evidently work sites of small, family bands. However, those subareas enumerated above under "Fauna" may have been kill and animal processing localities. After butchering, a few choice cuts of prey animals may have been packed into the camps in quadrants A and B, accounting for the random bone scatters, different from the arcuate distribution around the pond area (see Fig. 70B).

Most hunting appears to have been done with thick, ovate bipoints, another indication of considerable relative antiquity for camps in this area, which were less used by Proto-Clovis and Clovis hunters.

FIGURE 70B. Stake 10, distributions of artifacts and flakes. Broken lines enclose suggested groupings.

Another special mention should be made of seasonal transhumance as it can be inferred from concentrations of different kinds of stone shown in the flake scatters in Fig. 70B. Stake 10 was one of two special test areas where we undertook the laborious job of recording the raw material from which each flake had been made—a considerable task within a 305 m square. Combinations of jasper and glassy basalt of very fine crystalline structure have been selected for observation and marking on this map because both are available in neighboring Panamint Valley. Both, also, are less-favored among the rock categories composing Lake China PaleoIndian assemblages. Therefore, occurrence of these rocks three times within a reasonable spacing (marked with a heavy, broken line) might indicate the presence of three individuals (or groups) who had just been in Panamint. An inspection of the Stake 10 histograms (Fig. 70C) indicates the following tool-activity correlations as a guide to what people might have been doing on these sites:

1) Flake cores—(new tool manufacture).
2) Saws—(woodworking).
3) Spur beaks—incising (Fig. 70D).
4) Broad beaks—boring, reaming. (Fig. 70D).
5) Scraper—(planing, smoothing, peeling, cleaning, dehairing).
6) Cutters of all models—(slicing, fine trimming, making skin clothing or cutting skin strips for fur-string garments).

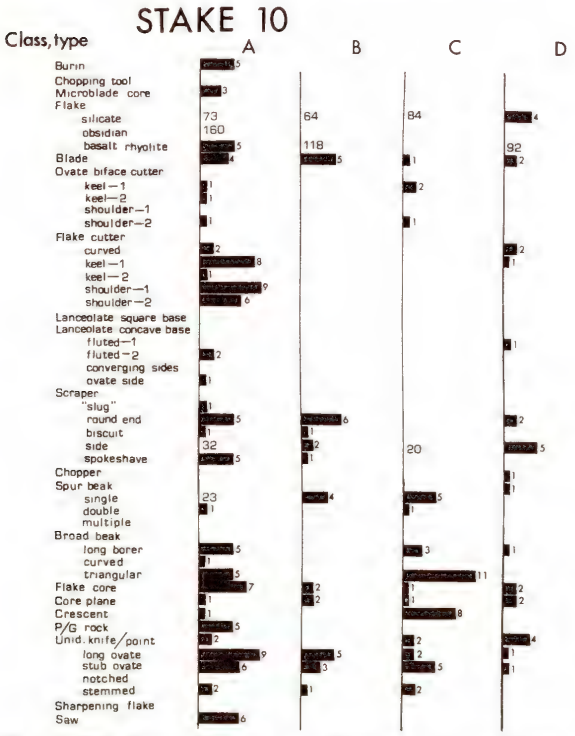


FIGURE 70C. Stake 10, histograms showing numbers of flakes and artifacts.

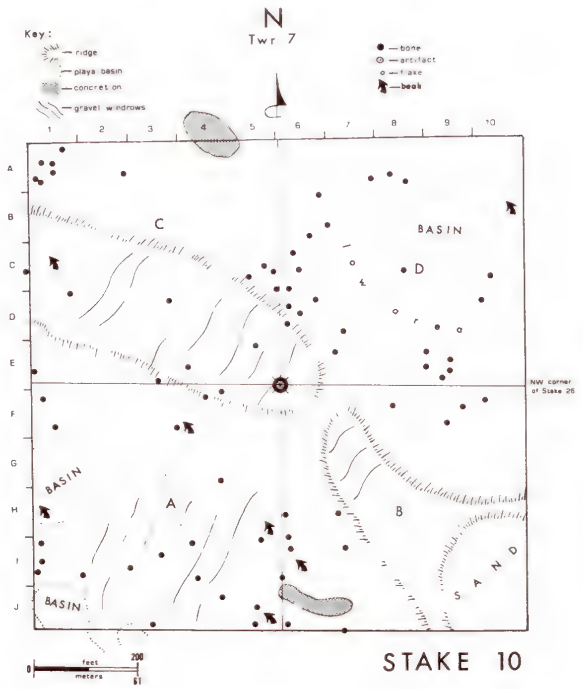


FIGURE 70D. Stake 10, distribution of all beaks (curved arrows).

Stemmed objects attributable to a Lake Mojave connection (''Lake Mojave'' still remains to be defined) are scarce (see Fig. 70E). There also are few crescents (Fig. 70F).

Paleocultural affiliations.—Late Wisconsin Cultures with ovate bipoints; Clovis of Ovate Tradition; Clovis of Lanceolate Tradition; Lake Mojave; and possibly Degenerate Clovis in association with late Lake Mojave and early Pinto.

Dates.—No radiocarbon dates have been sampled for Stake 10. A very crude projection would be that parts of the locality were used at infrequent intervals between 16,000 and 8,000 years BP. Most of this action probably was associated with an eroding paleosol formed between 10,000 and 7,000 years ago, and with the lacustrine gravel supporting that soil. A few tools are probably connected with an older, largely eroded paleosol and a somewhat larger aggregation may belong with the weak, upper soil. These hypotheses are extreme long shots and this locality should be reworked and verified for correlations with stratigraphic features. When we surveyed Stake 10 three years ago, existence of Wisconsin-Subrecent stratigraphies and any associated dates, were unknown.

A *few of the implements here are extremely weathered and appear to belong with inventories older than Lake Mojave or Clovis.* This locality should be restudied by arraying all flakes and artifacts on a sorting table beside the plane table map and plotting arrangements

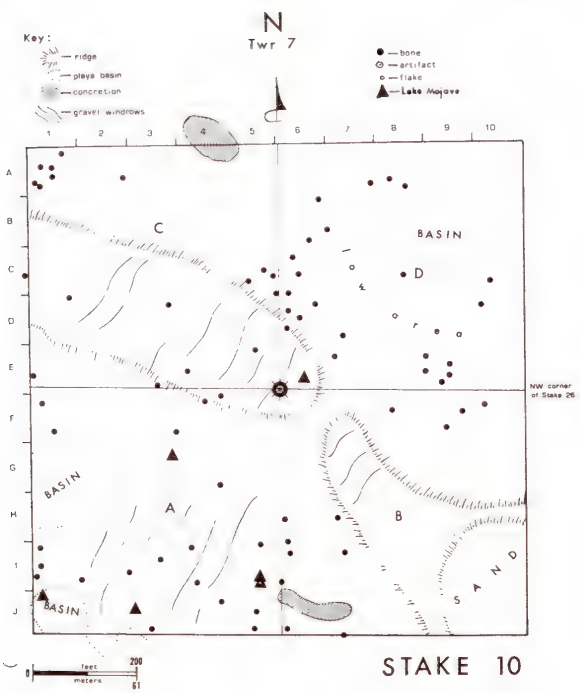


FIGURE 70E. Stake 10, distribution of stemmed, Lake Mojave objects shown as black triangles.

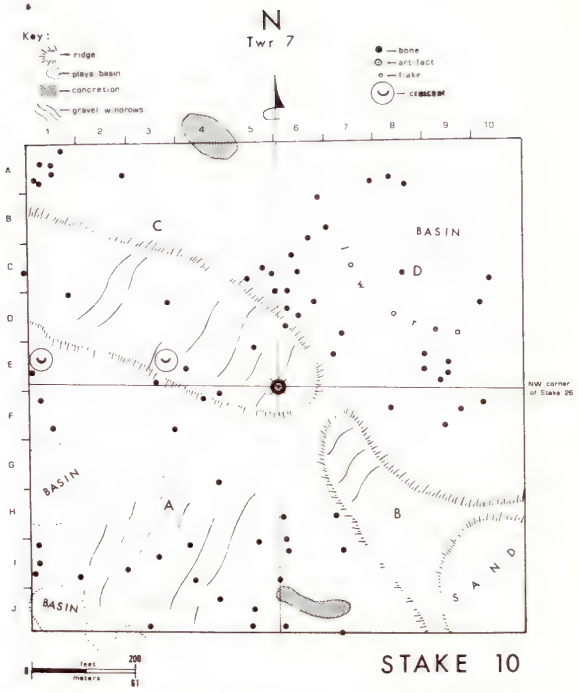


FIGURE 70F. Stake 10, distribution of crescents, shown as inverted arcs, circled.

of tools which belong in different categories of physical weathering.

Artifacts and discussion.—Raw materials, tool classes and their probable significance for cultural reconstruction have been sketched in the previous section on "cultural activities." In addition, other critical observations were made about these assorted tools, such as noting degrees of relative weathering and kinds of rock—particularly Rainbow Ridge chalcedony and some unfamiliar chalcedonies and cherts. These stones bespeak seasonal rounds of foraging, which differ slightly in target and trajectory from the rounds of most Lake China visitors.

The artifacts are also different, a fact which should be explored during subsequent microanalyses. At an impressionistic level of observation, Stake 10 tools are individually somewhat eccentric and as a whole assemblage, they represent unusual proportions of otherwise familiar instruments.

The following special objects were noted:

1) A blade from a polyhedral core?
2) Beaks of unusual forms.
3) A relatively high number of saws (6 in Quadrant A).
4) 5 possible burins of which 3 were made with true burin blows.
5) 3 flake cutters which are intentionally "backed."
6) 3 microblade cores.

The irregularity of flake tools, in general, combined with the tiny size of the above microblade cores emphasizes the enforced parsimonious nature of all Lake China tool production—it was a long hike for more stone.

STAKE 13

Discussion.—Stake 13 was selected for intensive survey for two reasons. First, there was an unusual number of crescents scattered about in this locality and, second it contained a large basin that would give us an opportunity to test other people's theories about PaleoIndian criteria for choosing campsites. Judge and Dawson (1972) and Judge (1973) found that late PaleoIndian bison hunters in the Rio Grande Valley, New Mexico, had positioned their camps for three advantages: proximity to water; an elevation high enough to give a clear view of grazing lands to windward; and a situation N or NE (*e.g.* downwind) of the water source and grassland. Stake 13 is on the NE perimeter of a fossil pond basin or embayment (see Fig. 71A).

As we interpreted the theory, water was the primary attraction for humans and quadrupeds alike. Therefore, the people camped where smell and smoke would not frighten any animals who approached to drink. From here they worked into the wind when scouting for quarry or at the beginning of encircling drives. To test this model, we later established Stake 26 in the "hunting" sector of territory controlled by any group of campers on the Stake 13 knoll.

An important assumption must be made at this point—the human population of this valley was always very sparse. There never was more than one small site in use at any time in this part of the valley. Different bands probably had their own territories (like the recent Paiute) and may have defended them vigorously except during festival seasons of plenty, or when cooperating with other bands in large hunts (Wheat 1967). Generous scatters of artifacts like those in Stake 10, Quadrant A have doubtless been produced as an aggregate of many small deposits rather than as the trash of a single large group.

Elevation of datum.—2,171 feet MSL.

Situation.—Stake 13 is approximately north of Stake 8 but is removed a considerable distance from it by an E-W trending ridge along the N border of 8NE, and by the wide basin mentioned above. A small inlet of this basin is visible in Fig. 71A, Quadrant B. Note that there is much erosion and rill activity in all quadrants. These disturbances have caused downwash and deflation of many artifacts and bones. Bone, in particular, lies about in random scatters with three exceptions. These are a familiar, arcuate distribution in the NW corner of Quadrant C, (a shoreline?); a cluster in the north central part of Quadrant A; and three fragments near artifacts (including a beak) in the NE corner of Quadrant D, (see Fig. 71B). The consistency with which beaks are found closer to bones than are any other tools, is slowly building up a factual case for the use of various beak forms as scribers (in the case of the spur type) or burins and borers in the case of broad beaks.

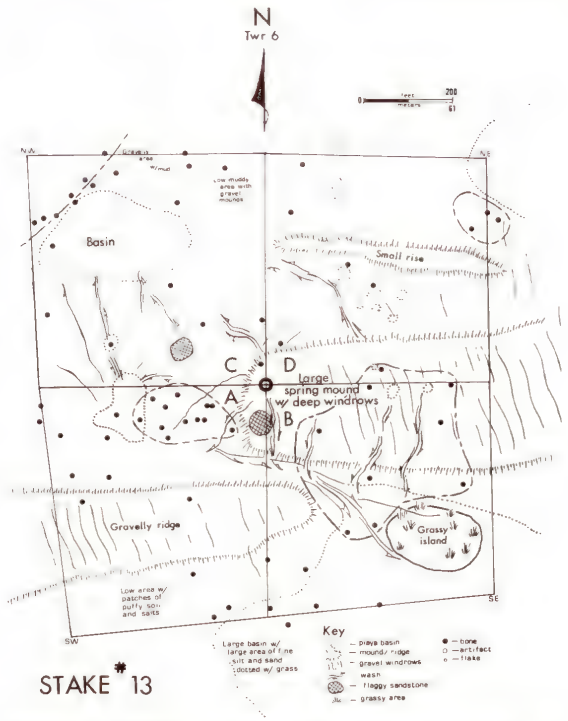


FIGURE 71B. Stake 13, landscape features distributions and possible patterns of bones.

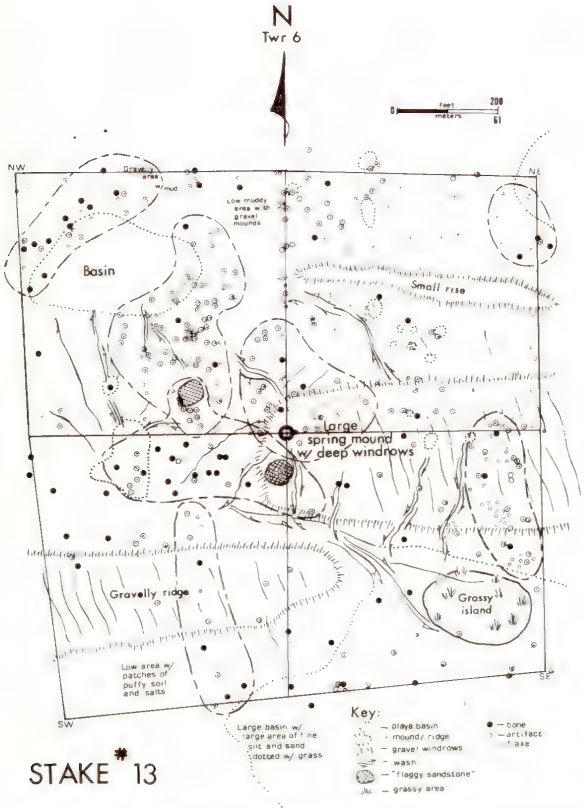


FIGURE 71A. Stake 13, distributions of bones, flakes and artifacts.

Surface deposits.—Lacustrine sands have been stripped away in this locality, exposing coarser and more cemented, pedogenic gravel. The soil that formerly capped this layer evidently contained much of the bone and artifacts. Remnants of it are shown as patches of "flaggy sandstone" (Fig. 71A-C).

Stake 13 was mapped late in 1971, before we understood the stratigraphic units and learned to recognize their characteristics. For this reason, the immediate vicinity of the instrument station was labelled "large spring mound" (our attempt to explain the quantities of flaggy sandstone on its surface).

Surrounding the two ridges of gravel windrows, rills are incising deeper beds of green clays, visible as beds of puffy mud (very treacherous when wet).

This locality and its contents have been much disturbed.

Fauna.—We know far less about this than we should. By now it is clear that we missed a fine opportunity by not having bone identified in the field when possible. Fortunately, this can be rectified in the future. Taxonomic identification together with records of the Munsell color of the specimen (a clue to its stratigraphic

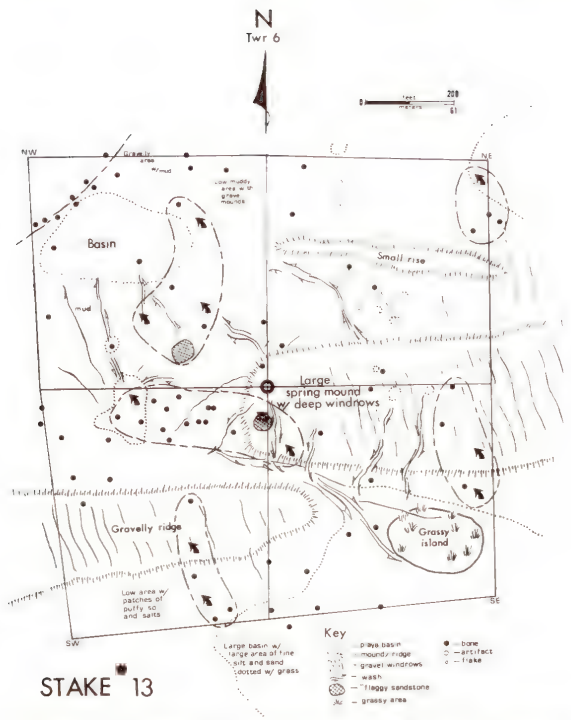


FIGURE 71C. Stake 13, distributions of all beaks (curved arrows).

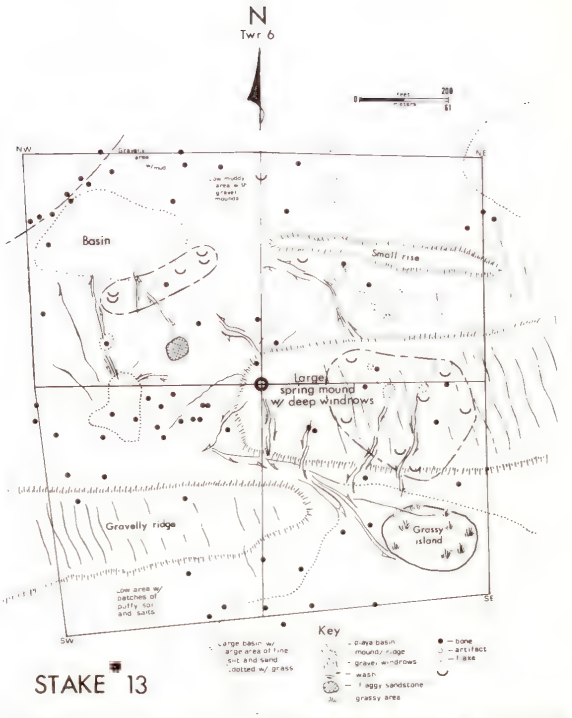


FIGURE 71D. Stake 13, distributions of crescents (inverted arcs).

source) would go far to document people-animal associations and build up a corpus of information about sequences of faunal extinctions.

At Stake•13 this was not done. It is possible that two of the bones were those of horses. Distributions of bones are indicated in Fig. 71B. Of these only three clusters may be candidates for association with people—an arc of fragments in the NW corner of Quadrant C.

Cultural activities.—This may have been an advantageous locality for hunting large waterfowl during a prolonged interval of climatic stability, when a strong soil was able to form and the lake level did not vary greatly. The strong soil at Stake 13 probably was related to the outcrops of flaggy sandstone at Stake 8NE. Destruction of this soil at Stake 13 has scattered the artifacts, leaving none protected as they still may be at 8NE and 8.

Distribution of crescents (Fig. 71D) is interesting—there are two scatters of them in entirely different kinds of places: on one of the gravel ridges along a boundary between Quadrants B and D, and in a low spot near the middle of Quadrant C. It is possible that this latter locus as well as the arc of bone in the NW corner of C, were associated with a beach, a possibility that should be investigated further.

For the most part, various bands who used this locality seem to have been busied with unexceptional camp chores, none of which have left any distinctive record. Crescents are the most characteristic tool in three of the four quadrants; therefore, it is likely that all these little sites may have been conveniently close to broad expanses of water sufficiently free of reeds to make the use of bird bolts practicable (if, indeed, that was the purpose for which some crescents were designed). A number of different styles of crescents and crescentics were used by Lake China foragers. Some of these forms were specialized and consistent whereas others were amorphous and idiosyncratic.

Crescent/crescentic styles, technology and use should be the focus of a small, special study based on these collections.

Paleocultural affiliations.—At present these are unclear but may come into focus when the collections are restudied. The crescents mentioned above are *not* cultural signatures. Everyone made and used them, from Late Wisconsin Cultures through Clovis and probably Pinto. However, shape, size and knapping technique changed with time.

Two objects are attributable to Lake Mojave (Fig. 71E) and another four fragments of unfluted lanceolate tools (Fig. 71F) may have been associated with some phase of Proto-Clovis.

Dates.—No dates for this locality are as yet available. The strong showing of ovate weapons and relative scarcity of Clovis/Lake Mojave forms suggest that Stake 13 may be relatively early. This view is supported by the fact that one of the unfluted knife/points is of

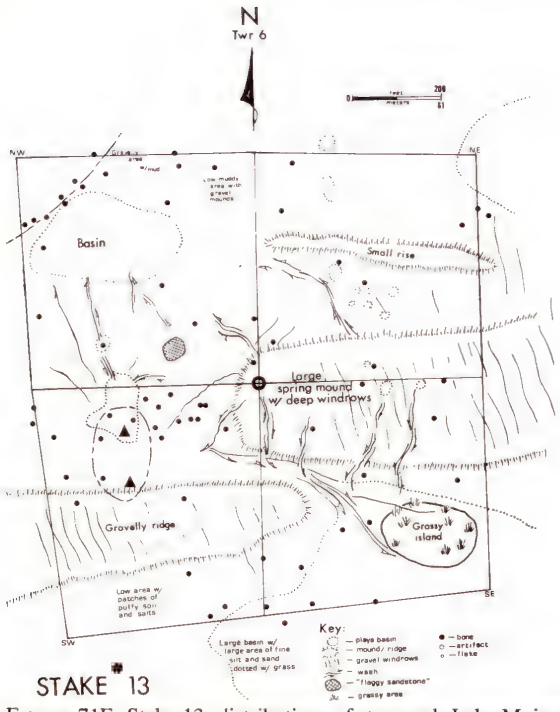


FIGURE 71E. Stake 13, distributions of stemmed, Lake Mojave objects shown as black triangles.

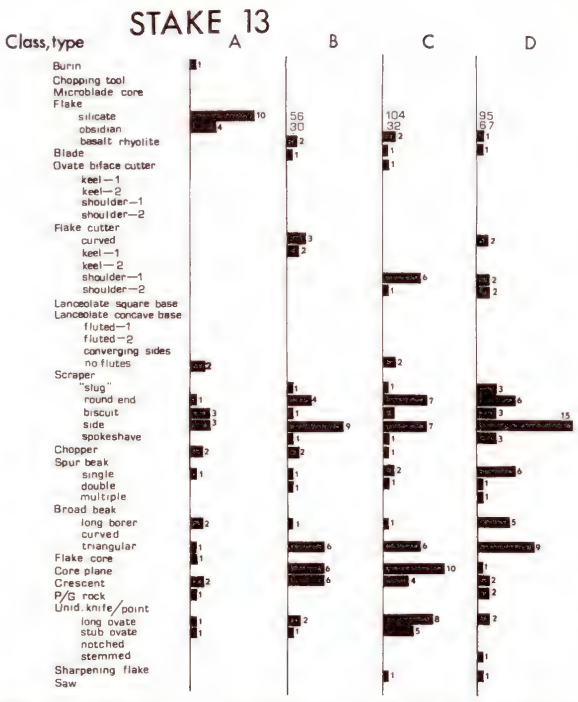


FIGURE 71F. Stake 13, histograms showing absolute numbers of artifacts and flakes.

Proto-Clovis knife style with a single, faint shoulder.

Artifacts and discussion.—The campers' choice of stone, (they used jasper and chalcedony more than obsidian), also supports the proposal that this locality was used "early." Some experimental arrays of tools from various sites indicate that rhyolitic glass came into popularity at some time during tenure of the Wisconsin Cultures, increasing in value through Clovis and Pinto. Selection of raw material gives another interesting bit of information about some of these people—they not only came in from the south; they stopped off at Rainbow Ridge for some of the beautiful, mottled jasper.

In general, the Stake 13 sites were low in cutters and high in scrapers. Three individual tools of particular interest were found in this locality: two very small-notched spokeshaves (for basketry splints?) in Quadrants B and C and a triangular broad beak with chisel (burin) tip in Quadrant D. To return to the microspokeshaves—we are increasingly convinced that a number of traits that became signatures of the much later Desert Culture, were established far back in the Upper Paleolithic of the Americas. These traits were basket making, stone milling, and use of fur-string and feather-string robes.

STAKE 26

This stake appears out of numerical order, but is included at this point with Stake 13 as part of an experi-

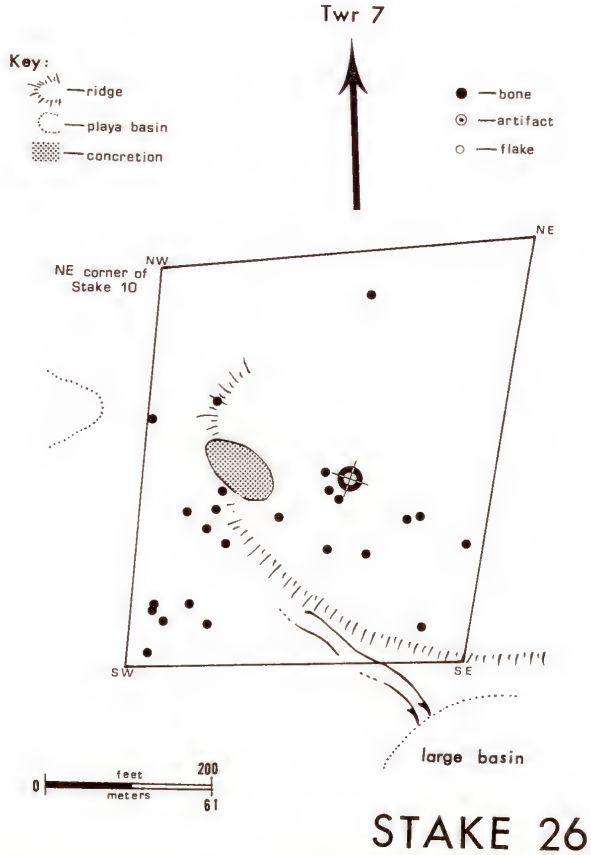


FIGURE 72A. Stake 26, showing landscape features, and distribution of bones.

mental sequence; Stake 26 was used as a control for Stake 13.

Stake 26 was small in area, approximating only one quadrant of the average survey stake. It was established as a test for different kinds of use of terrain both upwind and downwind from a sizeable body of water (the large basin shown in the SE corner of Fig. 72A). When all the information was assembled (see Fig. 72A-D), the results were surprising, because this locality of Lake China Basin *did not* agree with observations made by Judge and Dawson (1972) at PaleoIndian sites in the central Rio Grande Valley of New Mexico.

We had expected to find some evidence of hunting and trapping of large animals on this upwind edge of the water. Instead, this small test locus appears to have once been used for small camps where skinning, manufacture and work with various materials (carcasses, bone, etc.) were engaged in for brief periods. Both bone and artifacts evidently were associated with a strong soil, remains of which are visible as a patch of concretions.

Altitude of datum.—2,173 ft. MSL.

Situation.—Most of Stake 26 is on an expanse of gravel eroding at its west and south edges toward a large and a small basin. Note that the NW corner of Stake 26 joins the NE corner of Stake 10, so that the two stakes share a short segment of boundary. Also, the NE corner of Stake 26, adjoins the SW corner of Stake 13.

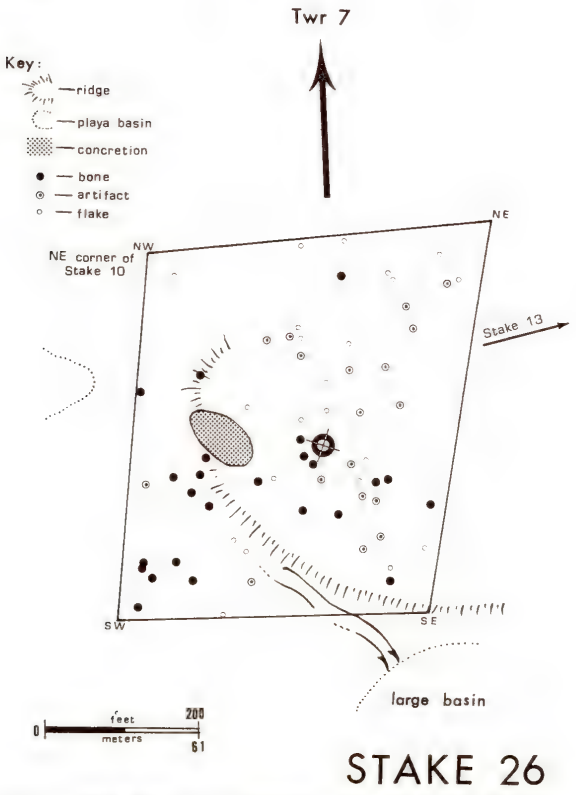


FIGURE 72B. Stake 26, distributions of artifacts and flakes.

Surface deposits.—These range from fine sediment filling the two basins to coarse, formerly cemented gravel that supports a culture-bearing soil.

Fauna.—Out of 24 bone fragments at this stake, *17* were identifiable as follows:

Taxon	*Identifiable Individuals*
Bison sp	1
Mammuthus sp	1
Camelidae	8
Equus sp	6
Canid	1

More than 50% of the bones and 90% of the artifactual stone appear to have been associated with the paleosols on the ridge. This overlap suggests a probable degree of people-animal association. However, such association may have been the result of secondary processing rather than of primary hunting activity. It may also have been the result of non-synchronous deposits. Opposed to this view is the fact that one bone just NW of the site was an almost intact pelvis of a horse. Since the pelvis is one of the bulkiest parts of the horse it would seem easier to have butchered the animal where it was killed and then carry segments of the body to the campsite. However, this pelvis (which was a small

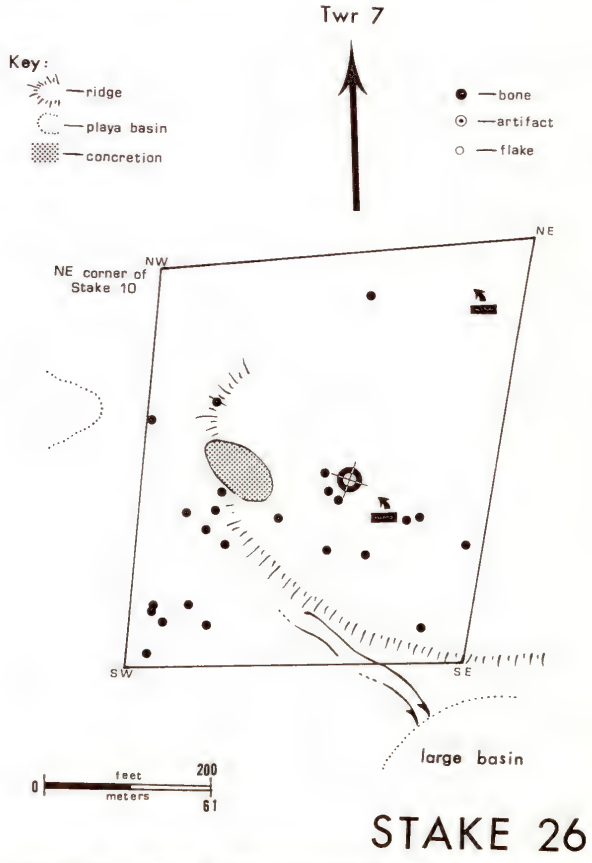


FIGURE 72C. Stake 26, distribution of all beaks (curved arrow and bar).

FIGURE 72D. Stake 26, histograms showing absolute numbers of flakes and artifacts.

one) probably belonged to the smaller of two kinds of equids in this area; one about the size of a dray horse and the other about the size of a burro. Thus it would not have been difficult for a crew of people to have carried a whole burro-sized animal onto the scene of camp activity. This suggestion in turn raises the possibility that the horse may indeed have been felled on this spot. If true, this would mean that Stake 26 was a hunting locus after all.

Cultural activities.—Two stone beaks suggest work with bone. The possibility of skinning mentioned above is based on the presence of two specialized ulu-shaped choppers. Were the people who use such implements mainly engaged in rough butchering and skinning of animals meant for camp at stakes 10 and 13?

Paleocultural affiliation.—No cultural connections were seen in the small collections of Stake 26 artifacts. This little camp locality seems to present another example of the cultural diversity which must have been characteristic of small, mobile bands in a thinly-populated countryside; people who repeatedly returned over long periods of time.

Dates.—None is available for this site. However, may we suggest that the six "slug" scrapers found here are probably connected with occupations of this area that took place during Late Wisconsin or Proto-Clovis phases, connection with the former being more likely, that is, before 12,000 years BP.

Artifacts and discussion.—In this locality, use of obsidian and silicates was virtually equal. The presence of flake cores indicates production of a few flakes, possibly for immediate use as tools. There were only two cutters for fine slicing, but more than five choppers, and ulus for chopping and hacking found here. The two uluforms, one made of jasper, the other of chalcedony, are so similar that they appear to have been made by the same hands. These two tools have a resemblance to an Eskimo woman's skinning knife, and their similarity to one another bridges a gap of time, giving a personal sort of encounter with a long-vanished woman who probably made them for the job she happened to be doing that day. In working with these many tools there have been a number of occasions when we were struck by the resemblance, the "artisan's touch" so to speak, in a small group of artifacts. It gave us a curious feeling of going back through the ages and actually meeting a fellow worker. The Proto-Clovis knife/point—the long lanceolate knives in this report—are another good example of this similarity. If you are yourself an artisan, it is easy to learn quickly to recognize the workmanship of someone else; you get to know their touch, whether in copper, wood, stone or clay.

STAKE 22

Discussion.—Stake 22 was the first locality in which we experimented with establishing metes and bounds and mapping the physiographic details, bones, flakes

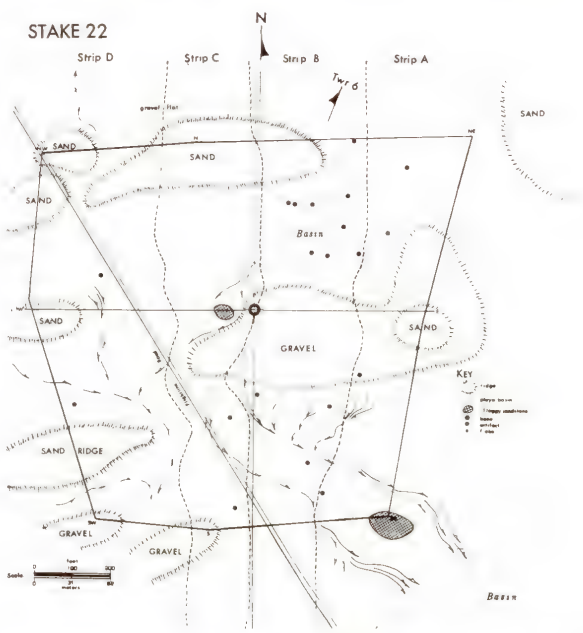


FIGURE 73A. Stake 22, showing landscape background and distribution of bones.

and artifacts in our site areas. Stake 22 was a trial run, and in some ways its execution left much to be desired. It was here that we began devising our field procedures. Initially, this stake area was divided into north-south trending strips A, B, C and D. Subsequently, on other sites, this practice of dividing up the stake areas was altered by dividing into quadrants, which were easier to control from the instrument station.

Stake 22 was important to us for three reasons: 1) it was the first experimental map; 2) the setting includes a wide variety of features and erosion stages, from undisturbed lacustrine sand to exposed soil remnants that survive as islands, and 3) this was the locus of Mammoth no. 2 with an associated chopper fragment and close to a camelid jaw (Fig. 73A, upper margin of basin in strip B). These specimens were being exposed by erosion and retreat of a sandy ridge immediately north and to the west of them.

Situation.—Stake 22 straddles the C1 Flight Line Road. It is south of Stake 10 and SW of Stake 9. The sites evidently were established on an elevated flat which was subsequently eroded several times.

Surface deposits.—These consist of cemented gravel, like those near the instrument station. Caps of sand become more extensive towards the west until they merge, masking deeper stratigraphic units. Effects of erosion are uneven: The instrument station ridge has a relatively level surface of gravel along its crest, but it is beveled away to the north and south at fairly steep angles. The residual patches of soil concretions (marked with cross hatches on the map) are doubtless part of the ridge structure before it was twice more inundated by the lake. The soil and gravel were evidently cultural surfaces where visiting foragers left artifacts. These tool locations are shown in Fig. 73B; they are exposed where the sands have been stripped from most of the station ridge, leaving only a cap at the east margin. South of this ridge, long and active rill systems are further incising the slope, leaving trails of artifacts on their interfluves.

Fauna.—There is an overall scarcity of bone throughout most of Stake 22 (see Fig. 73B) however, an important concentration occurs on the north margin of a playa in Strip B. Here a chopper fragment was found among bone fragments of Mammoth no. 2, a circumstance reminiscent of the chopper/proboscidean association at the Mammoth no. 1 locus. There was also an obsidian knife near a camel mandible and a crescent about 15 m distant from both the bone concentrations.

Cultural activities.—The tools that are inventoried in Fig. 73D histogram suggest both flake tool manufacture from cores, and also tool sharpening, which resulted in the waste of sharpening flakes. Possibly included would be jerky slicing or the manufacture of fur-strings for robes. Also indicated is cutting and chopping in connection both with butchering and the manufacture of gear, as well as hunting with bone points and with a single fluted knife/point (see Fig. 73E). (However, this would scarcely suffice for both a camel and a mammoth.) A surprising amount of blade manufacture also is included in this inventory—ten in all, which is a high score on Lake China sites. Only one stemmed implement of "Lake Mojave" pattern was found in a peripheral location (Fig. 73F). It prob-

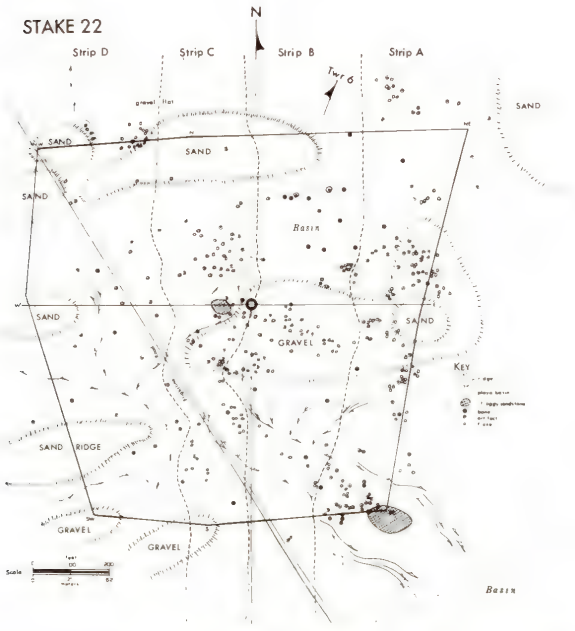


FIGURE 73B. Stake 22, distributions of flakes, bones and artifacts.

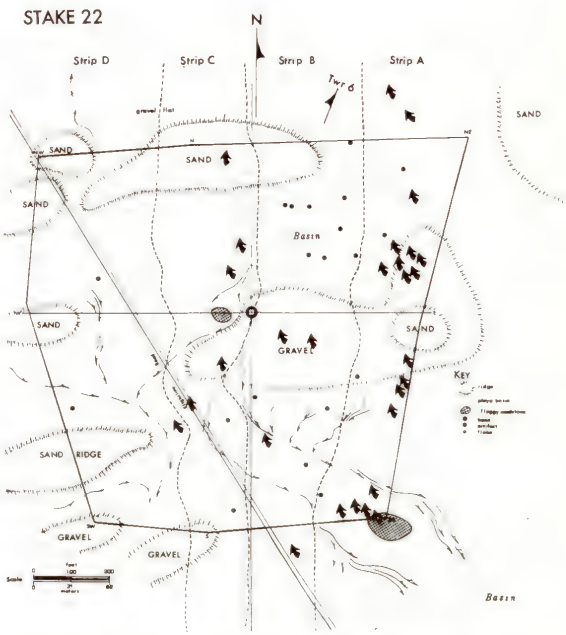


FIGURE 73C. Stake 22, distributions of all beaks (curved arrows).

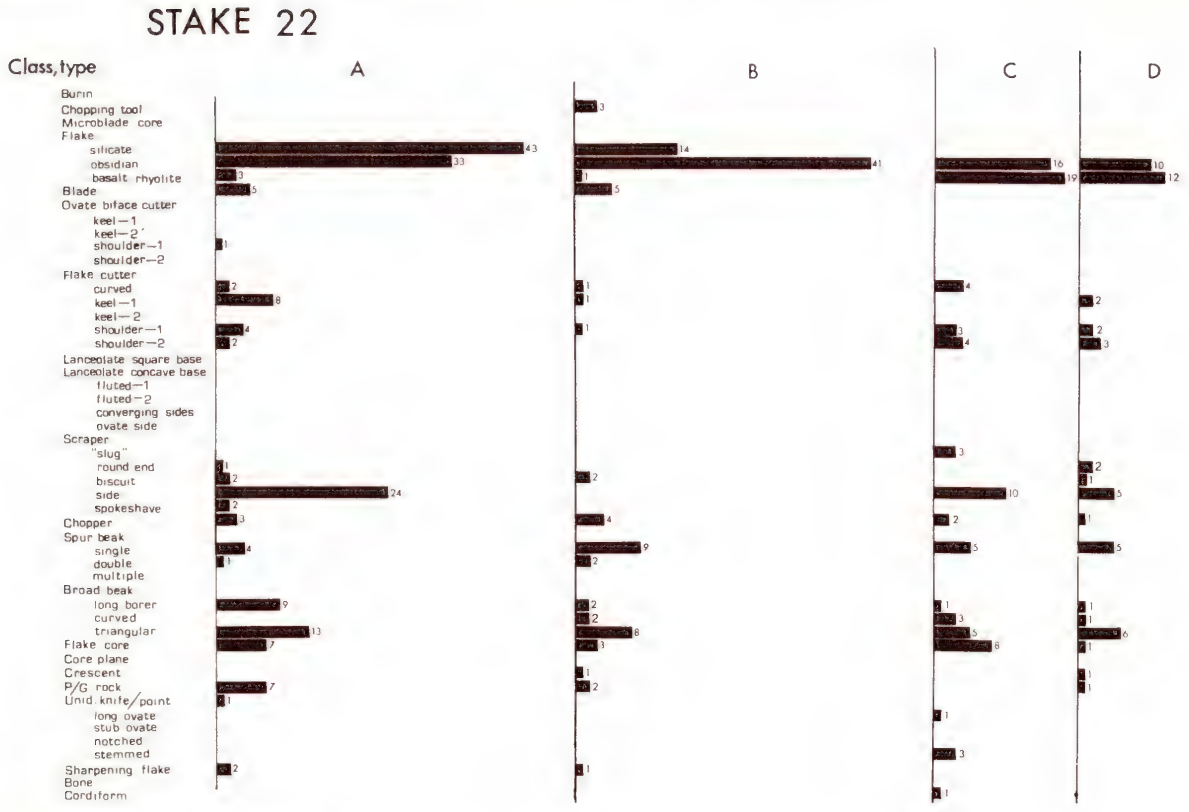


FIGURE 73D. Stake 22, histograms showing absolute numbers of flakes and artifacts.

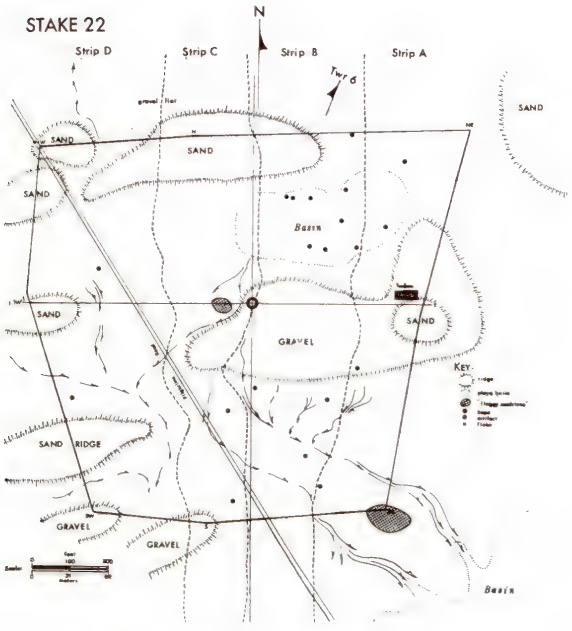


FIGURE 73E. Stake 22, showing location of single fluted knife/point (indicated as a bar-"f").

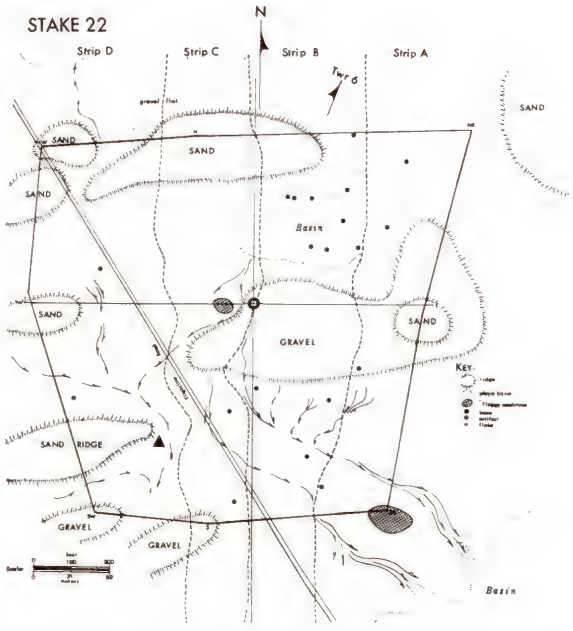


FIGURE 73F. Stake 22, location of single, stemmed Lake Mojave object (shown as a black triangle).

ably has eroded from under the sand ridge beside it and is remote from other artifacts. Any companions are possibly still underneath the sand.

In this Stake 22 locality, the four kinds of artifacts originally selected as diagnostic have no spatial relationship with two exceptions. Above the northeast corner of strip A, two beaks and a crescent are not far apart. Spatially, the best association is between the chalcedony chopper fragment and the limb joint of Mammoth no. 2, possibly butchered on the spot. The two crescents shown in Fig. 73G are not related and are about 100 m apart. For interpretation, they should be restudied as individual pieces to determine their technology and possible cultural significance. The plethora of side scrapers, (39 in all), suggests the repetition of some kind of rough cutting activity. A chopper, after all, is only a larger, heavier model of a side scraper; both, in general, will serve the same purposes.

The last (but not least) activity at these small camps after generalized pounding and grinding of materials must have been food preparation of many kinds as witnessed by ten of the unspecialized anvil and hand stones, which we have called "pounding/grinding rocks" or simply "P/G rocks." They are Paleolithic archetypes of the New World miller's art—preadaptations to the desert culture of the later Chichimeca in Northern Mexico (Di Peso 1975:53).

Paleocultural affiliations.—These are poorly documented in the Stake 22 terrain, consisting only of one object of ovate tradition and one of lanceolate tradition.

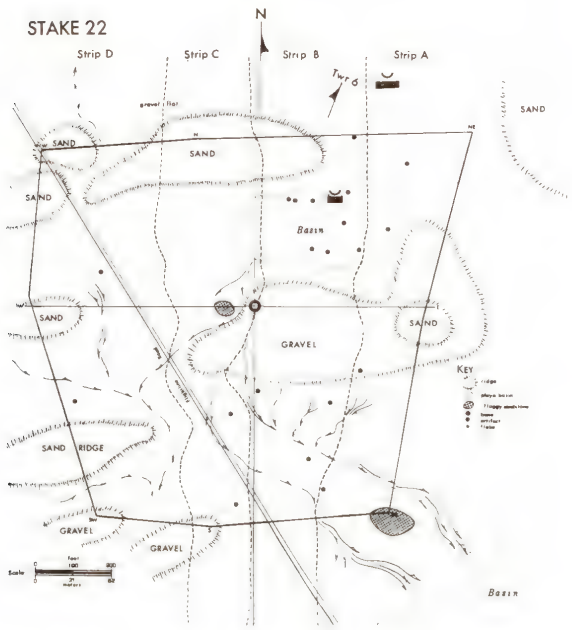


FIGURE 73G. Stake 22, locations of 2 crescents (inverted arc and bar).

Crescents of various designs and many kinds of beaks are not diagnostic of any cultural affiliation so much as of possible work activities. Therefore, these latter artifacts tell us more about on-site activity (within highly speculative limits), than about cultural traditions.

Dates.—No samples for radiocarbon dating were taken from this stake. It is, however, assumed that a preponderance of the bones and artifacts were deposited on a dense lacustrine gravel and the soil that formed on top of it. A number of dates for this soil are shown in tables found later in this report in the section on geology (see George I. Smith, this volume), accompanied by additional information compiled by Smith.

Artifacts.—The tools from this site have been discussed under other headings above, but now is the proper time to ask the question. "Why have we found just two mammoths (about 1 km apart) each associated with a chopper, but with no evidence of stone points for killing them?" One is tempted to postulate that elephants were trapped in bogs, killed with bone harpoons or long bone points and then butchered with stone tools—choppers and scrapers during early periods, fluted knife/points of lanceolate pattern later on.

THE PLAYA, BENCH AND DRAINAGE SITES

General discussion.—These stakes and sites, which form a natural chain, are illustrated in Fig. 74A (a map) and 74B (a diagrammatic profile). Starting at the SW end is Quarter Stake 27, a control for the Stake 25 cluster—investigating possibilities of different kinds of land use on upwind and downwind sides of a sizable body of water. In this case, the hypothesis seems supported. The Stake 25 cluster was composed of vestiges of small, family-size camps distributed within these arbitrary survey units: Stake 25, Stake 25NW and Stake 19SW.

From the high bench, travelling NE, the string of sites includes Stake 19; the *Bison antiquus* skull; Mammoth no. 1; Mammoth no. 4 and a small (associated?) camp. These activity areas will be discussed together because they are naturally linked by an important drainage. Starting from the elevated knoll of Stake 25 a shallow wash with playa widenings forms just NE of Stake 19SW (see Fig. 74A). It meanders through the SE corner of Stake 19 (be careful not to confuse this with "19SW") and just beyond the eastern boundary it broadens into a series of playa/washes. At this point, which is shown in the Stake 19 maps, the drainage contained an unusually fine specimen of *Bison antiquus* (Fig. 74B). Cores of the straight horns still were partially preserved. The animal was so large that there was some argument as to whether it might have been *B. crassicornis*. Following still further down-

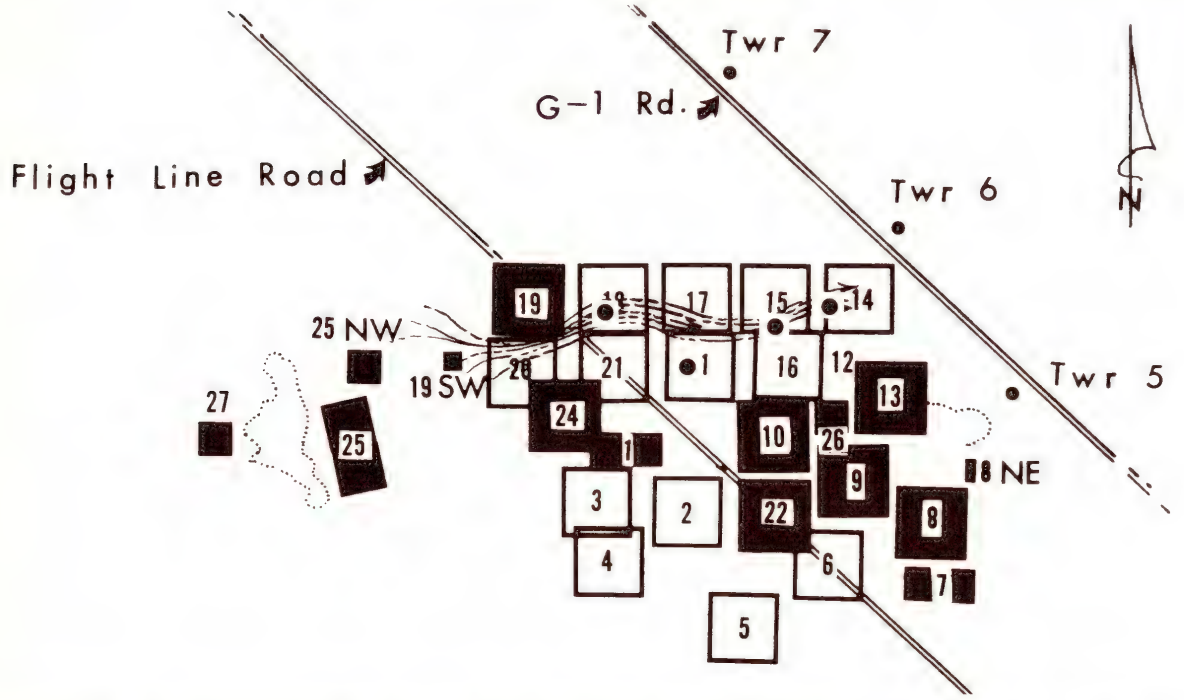


FIGURE 74A. Playa, bench and drainage sites: map showing relative spatial arrangement of the Stake 25 group (from Stake 27 to Stake 19); the *Bison antiquus* skull; Mammoths #s 1 and 4; and a small, processing camp.

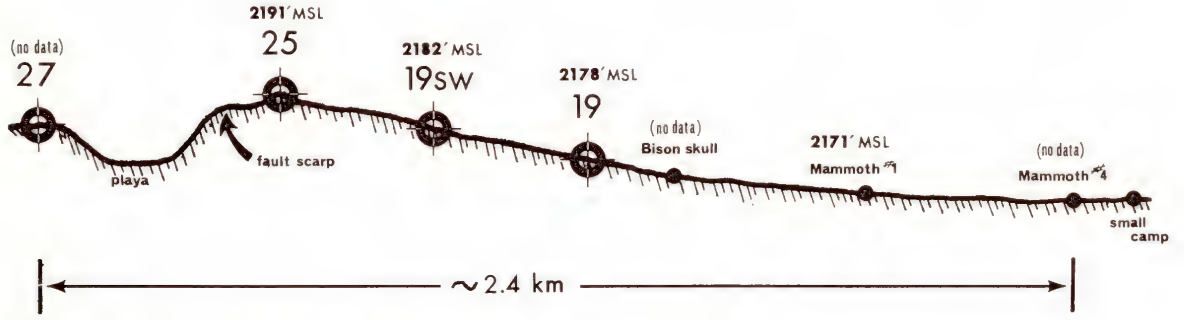


FIGURE 74B. Profile showing relative elevations of the playa, bench and drainage sites.

stream on the Fig. 74B diagram, the position of Mammoth no. 1 appears to be in line. Actually, this mammoth site (which we rechecked in June 1975) lies on what was probably the south bank. The remains of Mammoth no. 1 with a chopper and flakes were clearly associated with a strong paleosol underlain by complex lacustrine (and alluvial?) bedding including lenses of clay and gravel. We wonder if these equate with the Searles BC soil, about 15,000 years old (Smith 1968, Fig. 5).

To continue this cross-country trip down the meandering drainage, we come to the Mammoth no. 4 excavation. Remains of the skeleton indicate that it lies on its left side and only portions of the body were present: a 2 m long section of the left tusk; an articulated, distal foreleg (including the carpals and metacarpals); a large segment of rib and a number of other fragments. The right side of the animal was entirely missing either due to human removal of the upper accessible portions; to depredations of predators or simply to destruction by the elements. As an example of the latter agency, small shims of ivory were found for about 100 m downwind. No artifacts were found among the bones of Mammoth no. 4, but a large, chalcedony chopper lay about 20 meters to the east and a crescent was noted at approximately the same distance NE. The associations of these with each other and the proboscidean are unknown.

Mammoth no. 4 was buried in lacustrine (or stream?) deposits according to Fortsch. We rechecked the locality in June 1975, and determined that it carried remnants

of a paleosol—the only traces to be found in the vicinity. They are to be seen 75 m SW of Mammoth no. 4 and in line with Mammoth no. 1.

This soil trace near Mammoth no. 4 raises two important questions.

1) Was this the same soil that we found near Mammoth no. 1?
2) If so, is this equivalent to the Lake Searles BC soil, dating 14,000–16,000 BP (Smith 1968, Fig. 5)?

Further investigations to answer these question are critical. If the answer is positive, THIS WOULD MEAN THAT PEOPLE WHO BUTCHERED WITH CHOPPERS BUT DID NOT USE FLUTED POINTS WERE HUNTING MAMMOTHS 14,000 to 16,000 YEARS AGO. Mammoth no. 4 dates 18,600 ± 4500 years. BP (UCLA-1800).

In closing this section, mention should be made of the little camp on a gravel slope about 150 meters east of the mammoth. It was identified by an unusual number of pounding/grinding rocks, particularly a conical one with its smaller end facetted by battering.

STAKE 25: THE HIGH BENCH

Discussion.—Stake 25 dominates a complex of stakes, tests and controls, which are among the most interesting in the extensive survey area. The relation of Stake 25 to 25NW, 27 and the large playa are shown in Fig. 75A.

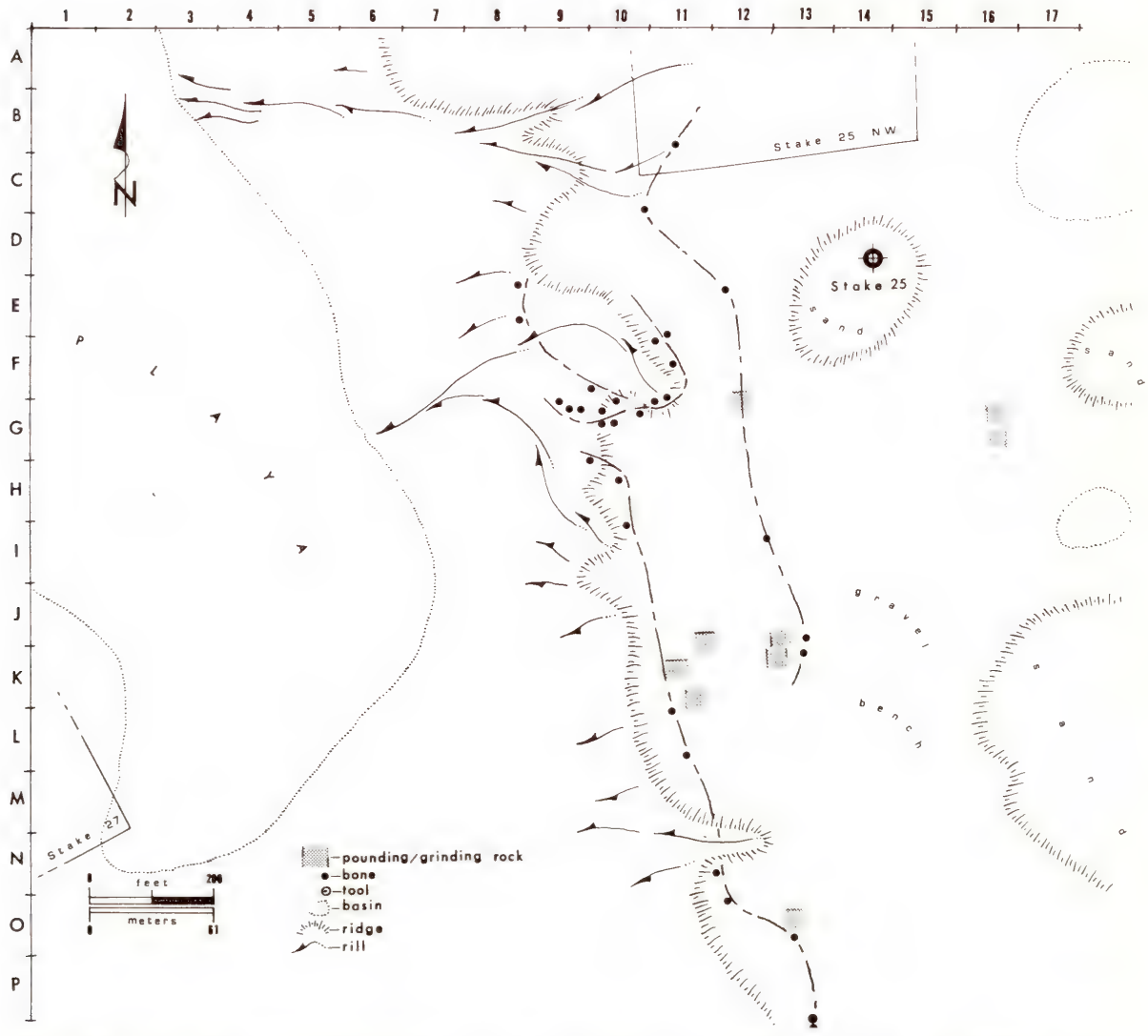


FIGURE 75A. Stake 25 bench showing distribution of bones and locations of control Stake 27 and test Stake 25NW on opposite sides of the large playa.

We have observed that this bench and playa site group of small camps appears older than most others in the basin for the following reasons.

a) More of the artifacts are extremely weathered.
b) Heavily weathered examples of Proto-Clovis knife/points (Long Lanceolate knives with one tiny shoulder) were first discovered here.
c) From a functional-morphological point of view, the assorted tool-kits that are thinly scattered along the bench, are more generalized than those characterizing other stakes further east or north. They are most strikingly different from the elegant, Classic Clovis tools that occur at Basalt Ridge and the adjacent M-184 localities. Also, Stake 25 people used a limited group of rock types; Classic Clovis bands drew on diverse resources—more people, more travel, more trade.

Comparison with Basalt Ridge.—It is interesting that Stake 25 and the Basalt Ridge locus could not have been occupied at the same time. When Lake China was deep enough to flood the Basalt Ridge embayment and make this locality inviting, Stake 25 was under 25 feet of water. When the Stake 25 bench and environs had a proper combination of grazing land; pond and marsh; and well-drained camp grounds, Basalt Ridge would have been a dry clay bed (22,000 years BP?) or a stretch of caked caliche (14,000 years BP Smith 1968, Fig. 4). Only twice after this was the Basalt Ridge embayment briefly useful to humans: during a Classic Clovis Phase (about 11,000 years ago?) and during a short Pinto Phase about 4,000 years BP.

In continuing a comparison of Stake 25 and Basalt Ridge in terms of characteristic stone technologies, the Stake 25 bench sites are characterized by the following lithic traditions:

1) Early and Late Core Tool Traditions.
2) Proto-Clovis.
3) Western Clovis of Ovate Tradition (refer back to Fig. 13).

The M-184 Basalt Ridge sites were used by increasingly larger bands of people who represented a long sequence of cultures with the following lithic technologies:

a) A trace of Late Core Tool Tradition.
b) Classic Clovis.
c) "Lake Mojave,"
d) Pinto

Elevation of Stake 25 datum.—2,191 feet MSL.

Situation.—A N-S trending fault scarp has created a flat bench about 1.5 km in length. Stake 25 datum is on a knoll of (lacustrine?) sand a little south of center on this flat expanse. The escarpment side drops off steeply to the west where a large playa fills an elongated basin with a western margin of low relief. Control Stake 27 is located on this margin (see Figs. 75A-F). Stake 25NW (a test stake for more intensive surveys including flake collections) is almost due north of Stake 25 and can be seen in the same figures. The relative position of Stake 19SW, however, must be checked by referring back to Figs. 74A-B.

Surface deposits.—Except for the Stake 25 datum knoll and two other hillocks of residual sand, the entire surface of the bench is composed of hard, reddish gravel. Depressions in this surface have filled with silt and appear as small playas, but none approach the large playa-basin in size. A series of active rills that feed into this large basin are incising deeply into the lip of the bench escarpment.

An inspection of these rill systems together with the distributions of animal bones (Fig. 75A) creates a picture of geological and cultural events of the past, *so that we are looking at successive stages of former shorelines, outlined by their cultural deposits, as faulting elevated the bench.* The older beaches should be to the east and the younger to the west (although this proposition remains to be tested).

During an intermediate stage of uplifting, a small cove was created at E-G/8-11. This cove, like the embayment at Basalt Ridge may occasionally have been a center of human activity focussed on killing and butchering large herbivores. The bone concentrations around the cove (mammoth; probably camelid and horse) are being exposed at the heads of washes; near one there was a Proto-Clovis implement, shown near the bone cove in Fig. 75B. Two beaks (Fig. 75C) may also have been associated if our interpretation of large beaks as useful both for butchering and for work in bone is correct. The hypothesis of a succession of shores having been formed by episodes of fault uplift is also supported by two parallel, N-S trending alignments of crescents (Fig. 75D). Note that beaks, two lines of bones and one long string of fluted knife/points also run north-south, evidence suggesting a westward retreating beach.

Fauna.—People/animal interactions seem highly probable in the locality of the cove with its unusual concentration of bone, suggesting that here there must have been some particular natural feature (perhaps a boggy shallow), which offered human hunters the sort of trap or advantage that was a part of their tactics. It is also likely that only human manipulation would have caused so large a percentage of the herbivores to die in one restricted spot.

The bone was mapped but not collected or identified. Since much of it is partially buried and protected, it was left untouched until we can return to the field and excavate extensive tests in this unusual area.

Recommendations.—When we resume field work on the China Lake Program, our focus of primary investigation should be the relationships of different animal species to the four (presumed) paleosols; when

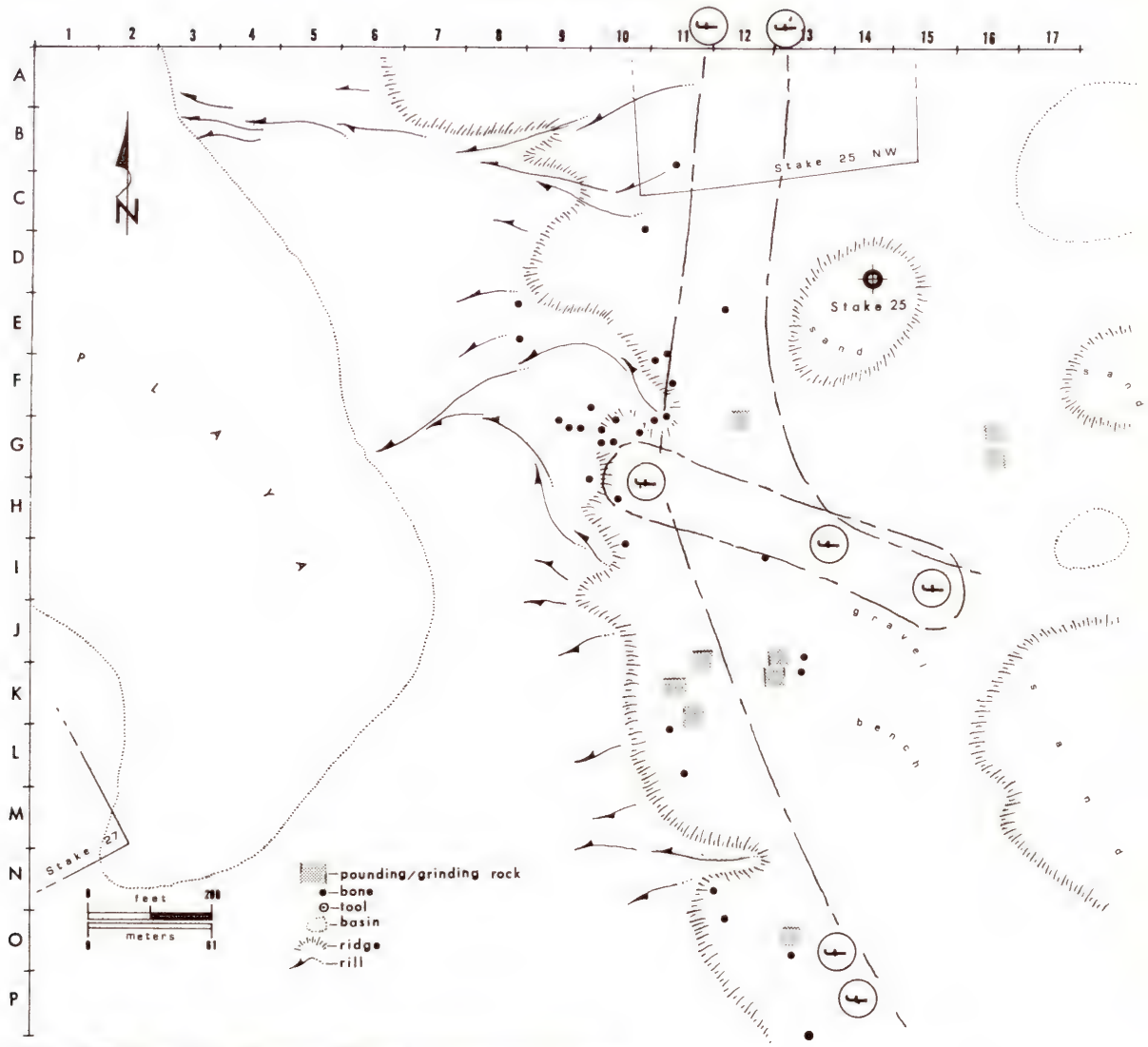


FIGURE 75B. Stake 25, distribution of Fluting Co-tradition knife/points.

did each species disappear from the scene; relationships of different human groups (particularly their proposed tool traditions) to the succeedingly older soils; and what was the changing relation of people and animals over time, (*i.e.*, can we distinguish archaeological differences in hunting volume and techniques?)

A testable hypothesis is that between 25,000 and 10,000 years BP hunting became more intense and aggressive (better technology); dependence on large animals became greater; and people probably increased in numbers by a factor of four. To get a maximal range of contrast in such tests, we should plan excavations at Stake 1, Stake 25 and Basalt Ridge.

Cultural activities.—We will find at least three different kinds of sites in this Stake 25 locality:

a) The kills.

b) Primary butchering activity.

c) Small, generalized, family band camps, many of which are marked by singles or nests of pounding/grinding rocks (Fig. 75E) shown on the map as stippled squares. There is no doubt that these unspecialized, unshaped (but exotic) rocks were used for everything including smashing bone. One isolated, action site was recorded on the north end of Stake 25 bench, where a group of bone fragments lay together with a pounding/grinding rock. There was nothing else around.

Over a very long time (15,000–20,000 years?) a few kills of large animals were made, up and down the beaches, by occasional bands of foraging campers. Success in trapping these creatures by bogging tactics evidently was well established, reaching a peak at some particular period (which we should be able to tie to one of the paleosols, and date) when the water level of Lake China reached almost as far west as Stake 1

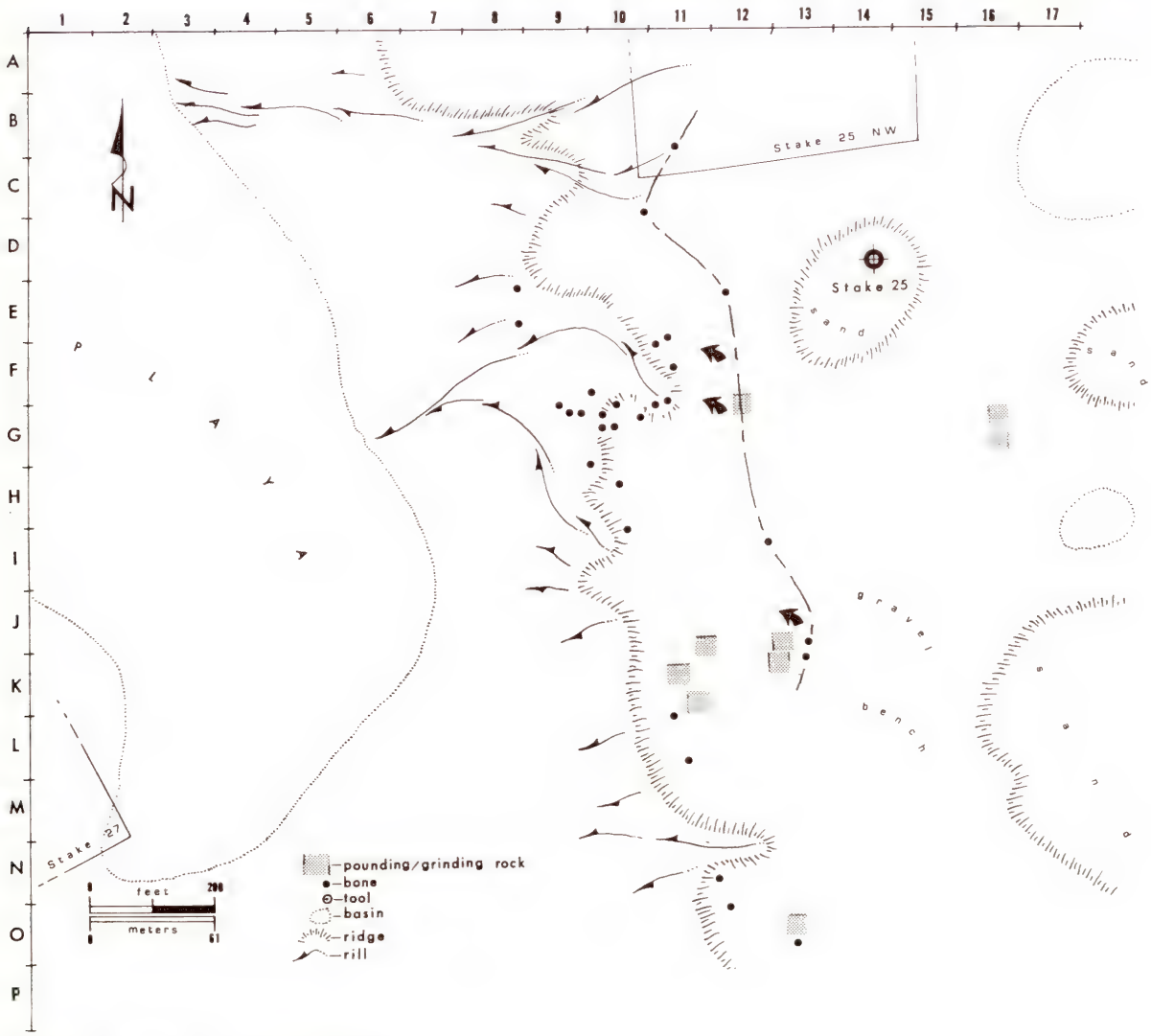


FIGURE 75C. Stake 25, distribution of beaks.

whereas the Stake 25 fault scarp was less than half its present height. This was, perhaps, a time when the bone cove was a small inlet on the eastern edge of a large pond. These are testable propositions.

During this interval (and at one period previously) some of the camping foragers also went birding for large waterfowl, which they hunted with casting javelins, armed with crescents (mounted "backwards") and possibly propelled with primitive self-atlatls.

The western rim of the bench was never heavily used (note the thin scatter of artifacts shown in Fig. 75E). This sparseness, however, may be due to the fact that regular, parallel patrols were not used on this stake as they were on most, and flakes were not specifically collected. Stake 25NW, which is only slightly further inland (and therefore more sheltered and hidden), indicates a very thick and universal scatter of flakes and tools.

Rather special conditions probably were required to make the bench a useful base of PaleoIndian operations: for which it may have needed narrow margins of balance between pasturage, water level and climate.

The histograms in Fig. 75F show that tool manufacture and sharpening were important, silicate rock and basalt being preferred over obsidian. In the Lake China basin, this preference is a primitive trait. It seems that at first, obsidian was not used at all but became increasingly popular with time although it never completely displaced fine grained jaspers and chalcedonies.

Butchering was evidently of major importance as indicated by the proportionally large population of (combined) chopping-tools, choppers and related side-scrapers. That is, the more steep-edge and massive choppers (edge angle = 73 degrees) are suited for the more heavy-duty parts of a disjointing task in which one would also want to use a "side-scraper" with a

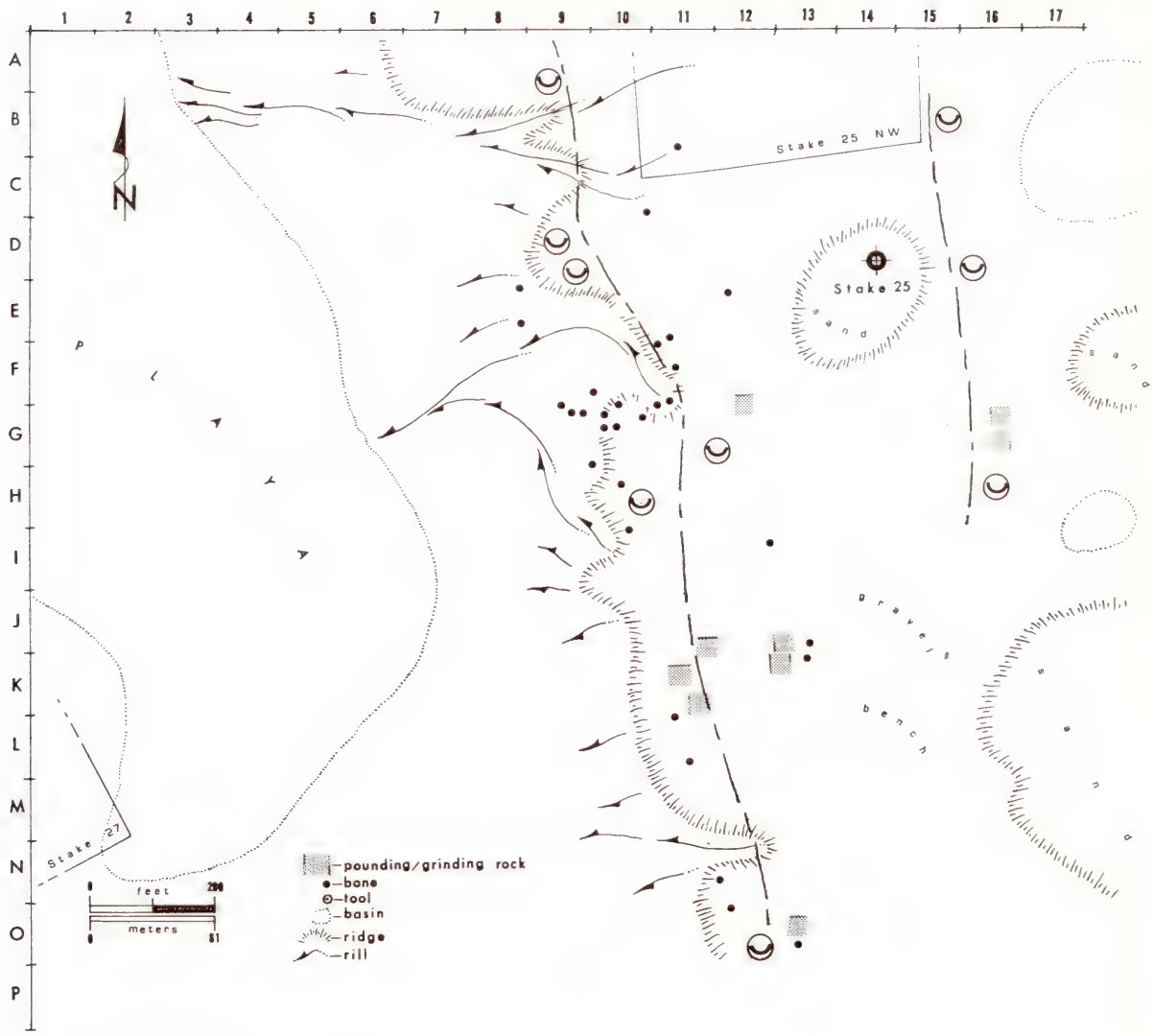


FIGURE 75D. Stake 25, distribution of crescents.

mean edge angle of 48 degrees (Wylie 1975:7,22) for carving and knife-action severing. Wylie has avoided "types" by a functional reanalysis of tools based on edge and body wear. This is the only way to approach tool classification (Semenov 1964) and is one we must continue to try to use with the badly sanded Lake China toolkits.

Fine slicing (like making jerky or cutting spirals of fur-string) was of lesser importance at Stake 25 where there is only a small number (7) of flake cutters. Most upper bench small tools of this class are of sturdier, bifacial design and, therefore, more suitable for hunting, skinning, sawing, etc.

Very little was done in the way of sizing or thinning wood with spokeshaves (of which there are only two in the collection).

Paleocultural affiliations.—These have already been enumerated in the first paragraphs as ranging from Early Core Tool Tradition through Proto-Clovis. This proposed sequence as viewed at Lake China will be illustrated and discussed again in the summary chapter. Lake Mojave objects, however, were omitted in the first estimates (above). Those that were collected are shown in Fig. 75G. Compare this with Fig. 75B that shows the distribution of knife/points of Fluting Co-tradition (in this case, Proto-Clovis). Note that of all the objects shown as separate distributions, *only these two classes appear to be distributed along two axes; north-south and east-west.*

This is another morsel of confirmation of an opinion we have long held and which is continually strengthened by work with Lake China toolkits: the complex called "Lake Mojave" and the complex called "Clovis" in the Mojave Desert are comparable cultures if not the very same. It remains for us to separate these poorly defined complexes into component parts, date their phases, make

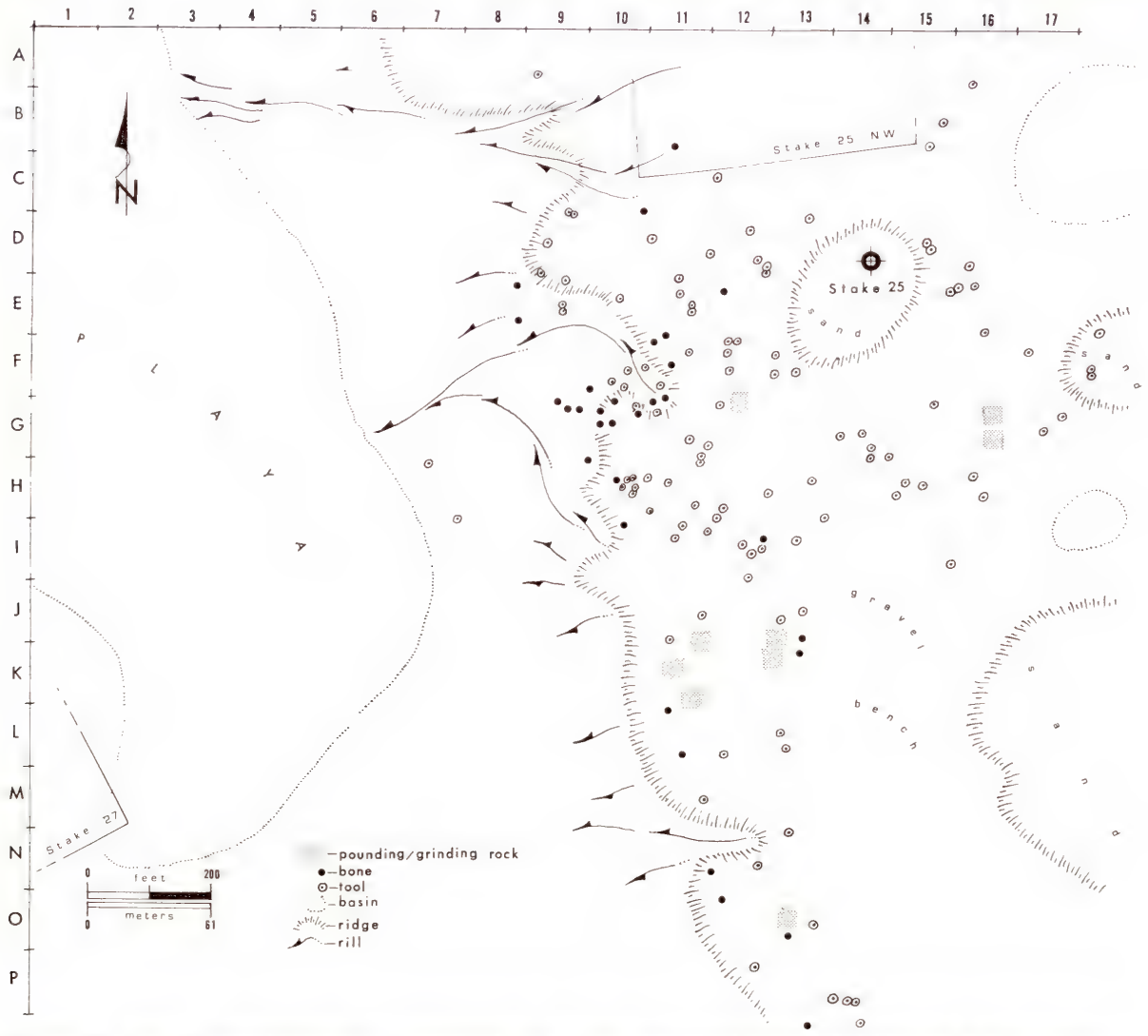


FIGURE 75E. Stake 25, showing total scatter of bones and artifacts. Nests of pounding/grinding rocks are shown as stippled squares.

microwear studies of tools, and resort them in a more sophisticated manner. Clovis has a long history in the Lakes Country and so does Lake Mojave, yet their nature, evolution and constituents have remained a mystery. Perhaps a carefully devised series of special studies with the Lake China collection, which is both a large and a controlled sample, will be a place to start this reanalysis.

No Classic Clovis was noted in the bench locality. This phase of the Fluting Co-tradition seems to be locked into a brief period during which Lake China was retreating from a penultimate high stand. The Classic phase is most strongly represented in the Basalt Ridge M-184 vicinity (along with Lake Mojave).

Artifacts.—Tools characteristic of the Stake 25 strip along the high bench have been treated *seriatim* under several of the headings above. It can be seen that they have variety but are, predominantly, members of the more ancient and primitive phase toolkits known in this valley. They are somewhat more rugged in both design and technology than are the stone products of later phases—and many are weathered almost beyond recognition.

Periods of site-use: speculations.—It is possible that the Stake 25 bench (and its ancestral beaches) saw brief habitation and use at least three times. The first might have been as early as 45,000 years BP; the second somewhere in the 30,000 year range; and another about 15,000 years ago. These highly speculative "guesstimates" are based on the proposition that usefulness of this bench depended upon the water level of Lake China (which fluctuated continually), and then are based on extrapolations to Lake China of the known levels of companion Lake Searles (Smith 1968).

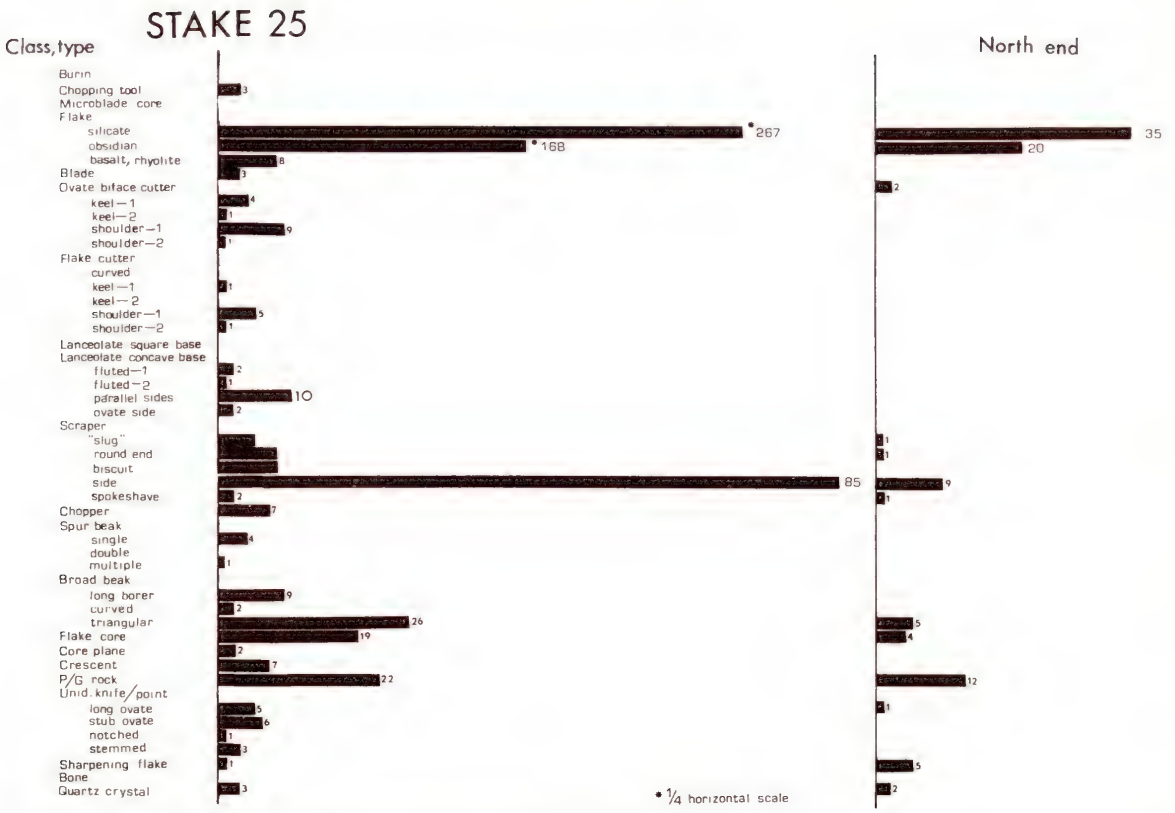


FIGURE 75F. Stake 25, histograms showing absolute numbers of artifacts.

Unravelling the geochronology of Pleistocene Lake China has top priority when we resume work on the China Lake Program. By now there is no doubt that traces of both ancient peoples and extinct animals are parts of the regional paleosols. Finding and dating these old soil remnants has become the goal of our program.

STAKE 27

Discussion.—This Stake is a small square, equivalent in area to one of the quadrants within most of the other surveyed stakes. Like Stake 26 it was established as a control for the Stake 25 bench: a test for applicability to site clusters in the Lake China basin of Judge and Dawson's (1972) PaleoIndian land use hypothesis—generated for sites in the central Rio Grande Valley.

Judge and Dawson (1972) observed that certain combinations of natural advantages were sought by late PaleoIndian bison hunters in New Mexico: an elevated campsite on the NE (downwind) side of water and with an "overview" of grazing lands upwind where animals would be less likely to smell them. The Stake 25-Stake 27 situation parallels this desired relationship, previously shown in Fig. 75A, indicating that one of the Lake China peoples' territorial strategies resembled a practice of New Mexico hunters. The custom of stalking upwind and using bog-trap tactics is probably as old as the Pleistocene.

The Lake China environment, however, was more varied and complex than that of the Rio Grande Valley, possessing more broad spectrum ecological resources: particularly the postulated areas of marsh. People appear to have lived around little knolls along marsh/grasslands interfaces. These shorelines varied continually with fluctuations of the lake, accounting for the wide, ubiquitous distribution of site clusters.

As an example of Lake China versatility, some of the foragers who camped on the Stake 25 bench sites evidently made use of the Stake 27 terrain on the other side of the basin; but some of them also killed mammoth, camel and horse around a bone cove closer to home. Perhaps these hunters made a kill first, after which the band settled in until it was time to move on.

Stake 27 tested satisfactorily as one of the high bench heavy beef sources.

Elevation of datum.—Not determined.

Situation.—Stake 27 is on the low, western margin of a large playa. Distribution of bone is along a rela-

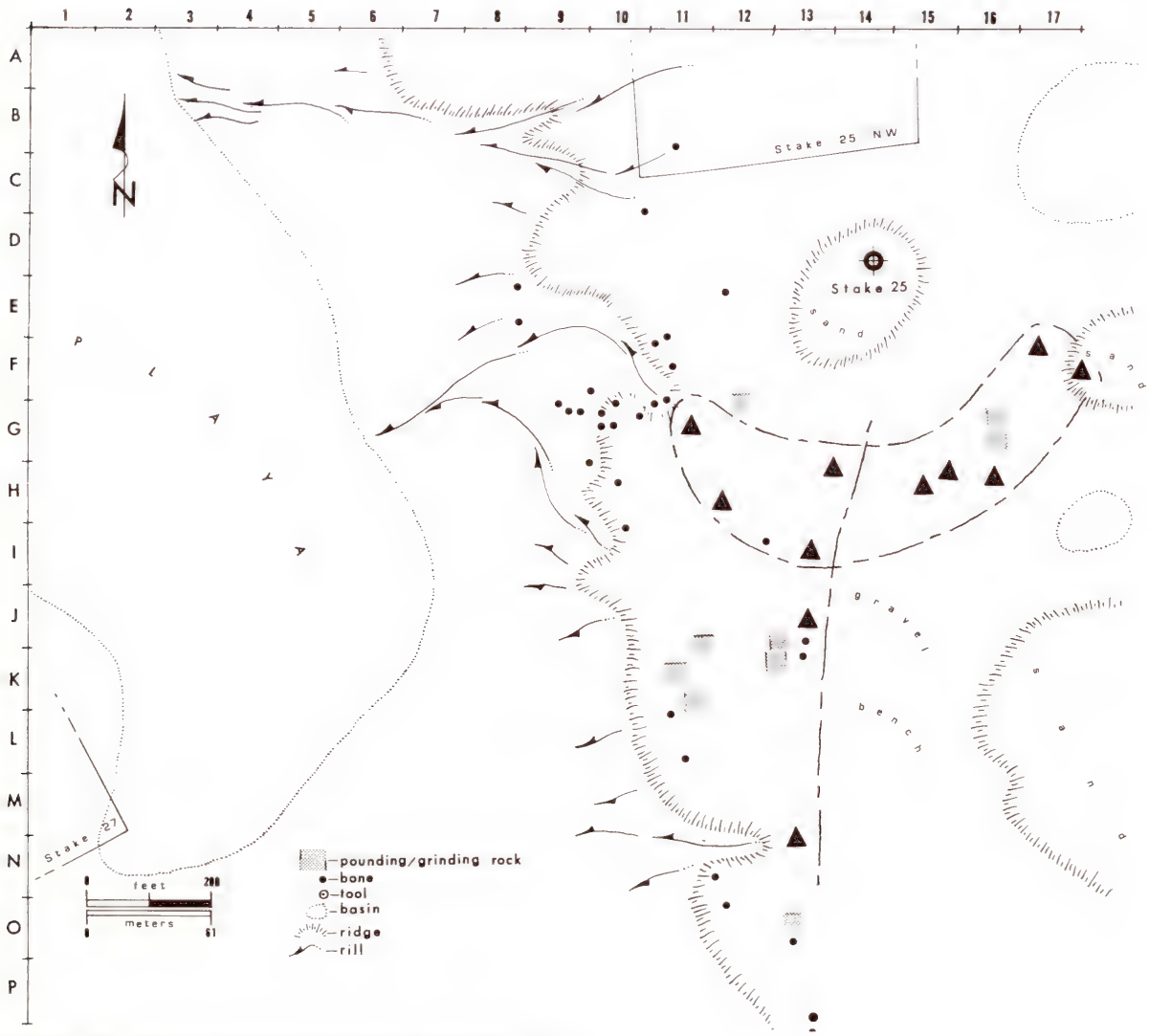


FIGURE 75G. Stake 25, distribution of ovate and stemmed objects.

tively straight north-south line (Fig. 76A) suggesting that at a time when a few people killed even fewer animals at this spot, this western side of the pond was straighter than the present, washed-in and meandering playa edge.

Surface deposits.—The instrument station is located on a sandy knoll composed of small particles that may be comparable to the lower member of the lacustrine cap at Stake 1. This sand is being removed by erosion, exposing underlying surfaces of hard, reddish gravel. No study has been made of soils or soil remnants at this locus.

Fauna.—Bone at Stake 27 was too fragmentary to be identified but was clearly the remains of large mammals (one or several?). Close association of animal bones and human butchering tools is proposed on the basis of two averaging lines (see Fig. 76A). Line A-A′ averages artifact scatters in the NE and SE sectors whereas line B-B′ averages bone distribution in

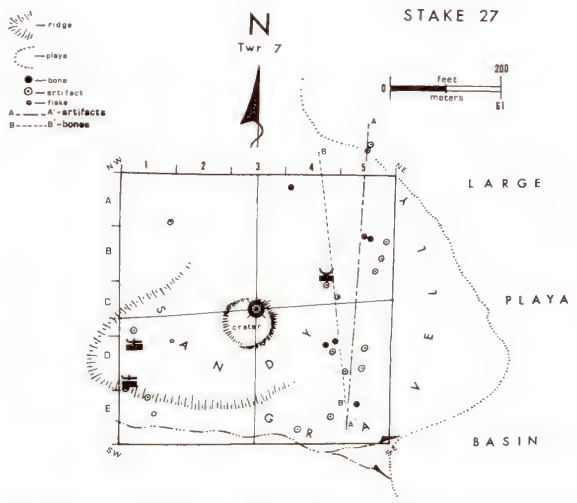


FIGURE 76A. Stake 27, showing close association of bones and artifacts. Line A-A′ indicates artifacts, B-B′ averages the locations of bones.

the same sectors. The angle of divergence of the two lines is only 11°.

Artifacts.—People-animal associations have a high probability because of this bone-artifact correspondence—a probability which is strengthened by the tool inventory (Fig. 76B). This toolkit possibly a single time component of instruments is proportionally high in butchering equipment (choppers: side scrapers) and in knives of a particular kind (to be described). There was also a single crescent (Fig. 76C) in the line of bones, a situation similar to the crescent near Mammoth no. 4. There is no explanation for this and it may be fortuitous; nevertheless the repetition is interesting.

The knives were distal fragments of two unfamiliar implements, originally classed as "long ovate" (Fig. 76B) because they lacked their diagnostic bases. This classification is now thought to be incorrect. As we have become far more familiar with various ages and categories of tools in the valley, these two objects appear as the distal portions of Proto-Clovis knives. They are long, lanceolate and have slight shoulders; the blades are curved on one edge and almost straight on the other; the tips of both are slightly but intentionally rounded—a good conformation for a skinning knife. They are made of different kinds of stone: felsite(?) and gray chert, the chert specimen being so sandblasted that no flake scars are discernible. Nevertheless, when these collections are restudied, particular care should be taken to examine these two specimens for any traces of fluting.

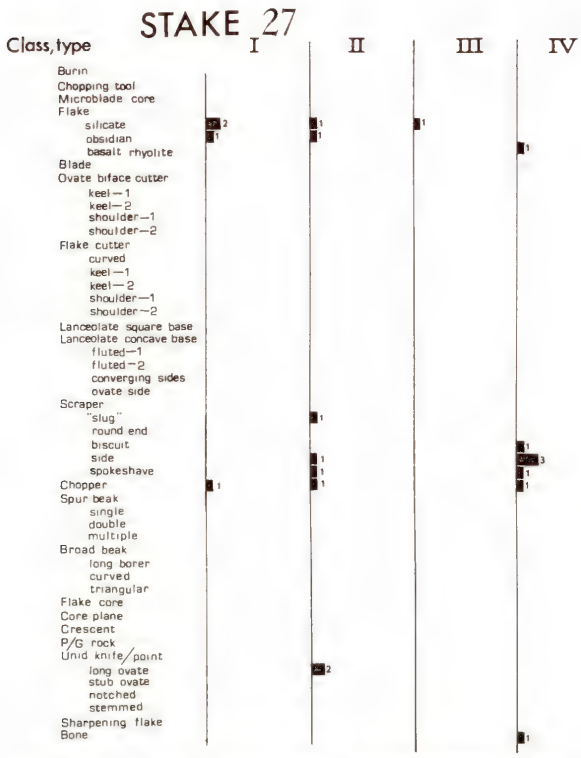


FIGURE 76B. Stake 27, histograms of artifact numbers in sections as follows: I (SW); II (SE); III (NW); IV (NE).

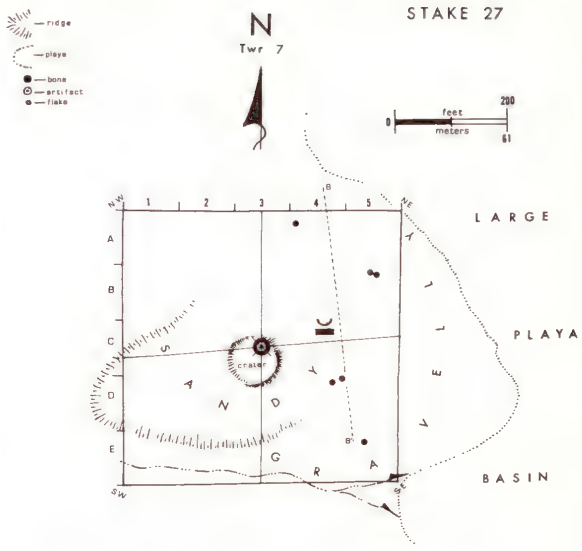


FIGURE 76C. Stake 27, showing location of crescent.

However, regardless of cultural affiliation, these two particular knives in so small an array of tools so closely aligned with bones of fossil mammals, add another piece of evidence on the side of human/animal association at Stake 27.

In closing we note that in writing up this stake report our system of making 5″ × 8″ artifact cards, illustrated and annotated in the field as each object was found, is validated. Had it not been for the clear notes and drawings on the cards of artifacts 27/II/A-2 and A-3 (the knives) a mistake would have been made resulting in severe misinterpretation of the locality.

STAKE 25NW

This is another small, high bench locality that was mapped as a control for Stake 25, 143 m to the south, measured from station to station. This work was an afterthought, considered to be necessary as a test of the artifactual population of the bench because the Stake 25 strip (an unusually large area of irregular proportions) had not been mapped for flakes nor had any flake collection been made there. It was necessary, therefore, to backtrack to achieve a controlled flake harvest and count. As we continued with analysis of our sample of surveyed localities, it became increasingly clear that flakes, *all* flakes, are a vital part of the information. Field procedures were the same we used within the rest of the Intensive Test Area: mapping was done with alidade and plane table; each quadrant was patrolled on tracks 4 feet apart by a surveyor who dragged a stadia rod to leave a clean trace, carried a pack of 5″ × 8″ edge-

punched cards for field records, and held the rod over each find for the instrument person (a neat trick in 40 mph gusts).

Elevation of datum.—2,185 feet MSL.

Situation.—Stake 25NW is on the plateau of the gravel bench, reaching almost to the rim.

Surface deposits.—These vary from hard packed gravel, interspersed with four little playas, to a sandy mound at the east corner. A system of active rills in the SW corner feeds into a long wash that cuts the lip of the bench and runs into the big playa about 150 meters north of the concentration of animal remains named the "bone cove," (see Fig. 77A).

Fauna.—There was very little bone in the 25NW survey locality: a cluster of four groups of fragments near the instrument station and three others down the SW 1/4 near the rill system as shown in Fig. 77A. The instrument station cluster is important, however, because of close association with two Proto-Clovis knife/points on one side (Fig. 77B) and with two Lake Mojave objects on the other. The latter are possibly knives (Fig. 77C). In SE sector II, a macroflake chopper of quartzite (II-A25) was recorded with one more piece of bone and three stone flakes. For some reason, the bone was missed on the map.

Identified animals in Stake 25NW were as follows:

Taxon	*Identified individuals*
Bison sp	0
Mammuthus sp	1 (?)
Camelops sp	1
Equus sp	1

Cultural activities.—The locality histogram (Fig. 77D) shows this part of the high bench to have been used by Late Wisconsin Cultures and Proto-Clovis foragers who were involved in the following kinds of work: large mammal hunting; rough butchering using chopper/chopping-tools and side scrapers); meat cutting (using also knife/points); bone smashing and general food processing with pounding/grinding rocks, shown as stippled squares in Fig. 77E; work with wood and bone; probably making fur-string and feather-string cordage; fowling for large birds (one instance) using a crescent (Fig. 77F); possibly making basketry and cordage; campside manufacture and repair of gear; production and resharpening of large tools and possibly manufacture of microflake, composite instruments with the flakes set in handles of wood or rib. Distributions of the pounding/grinding rocks suggest that these crude hammers mark the centers of small band camps.

Paleocultural affiliations.—Early and Late Core Tool Tradition; Late Wisconsin Cultures I; Proto-Clovis; a Late Wisconsin phase of Lake Mojave (Proto-Lake Mojave ?). Lake Mojave is particularly poorly defined.

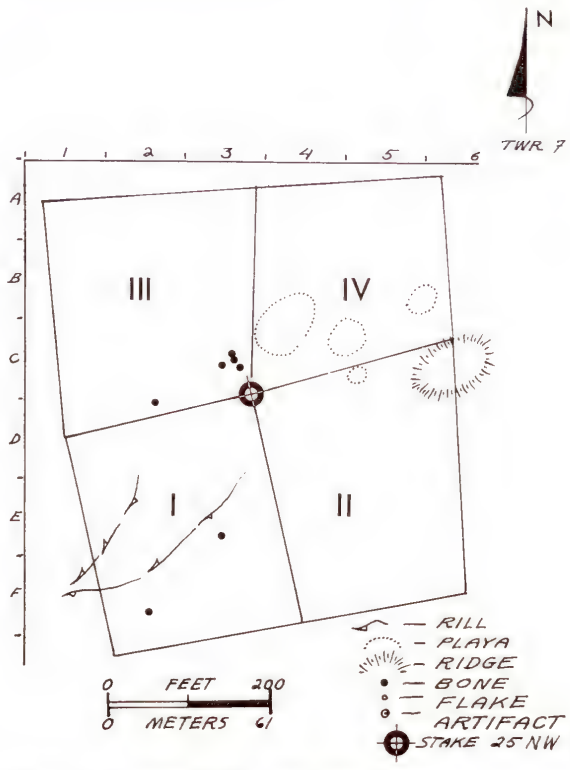


FIGURE 77A. Stake 25NW, distribution of bones.

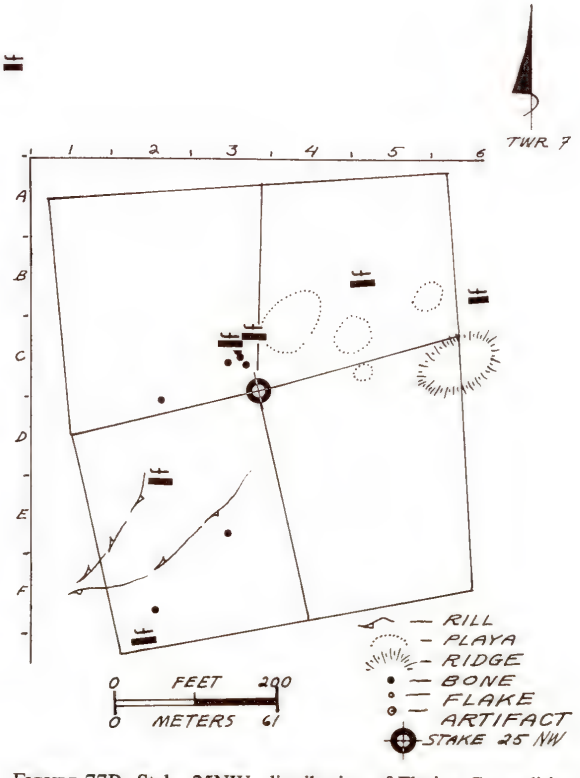


FIGURE 77B. Stake 25NW, distribution of Fluting Co-tradition knife/points of a Proto-Clovis phase.

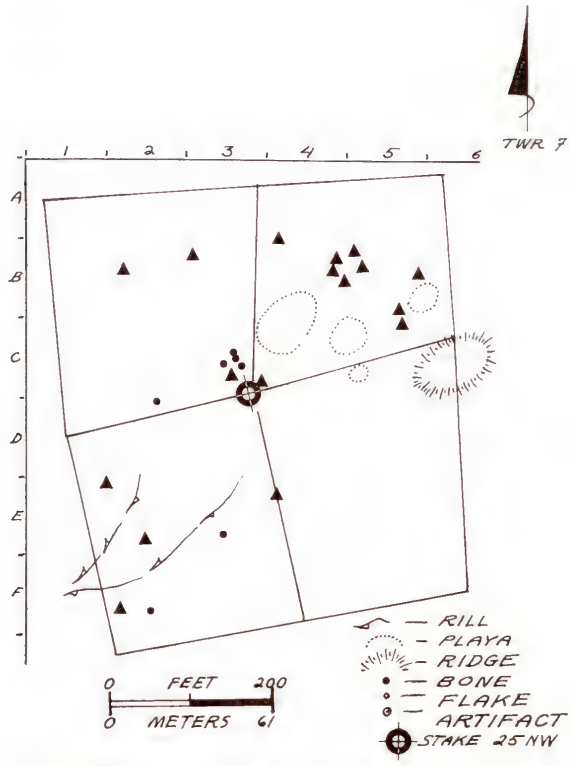


FIGURE 77C. Stake 25NW, distribution of "Lake Mojave" objects.

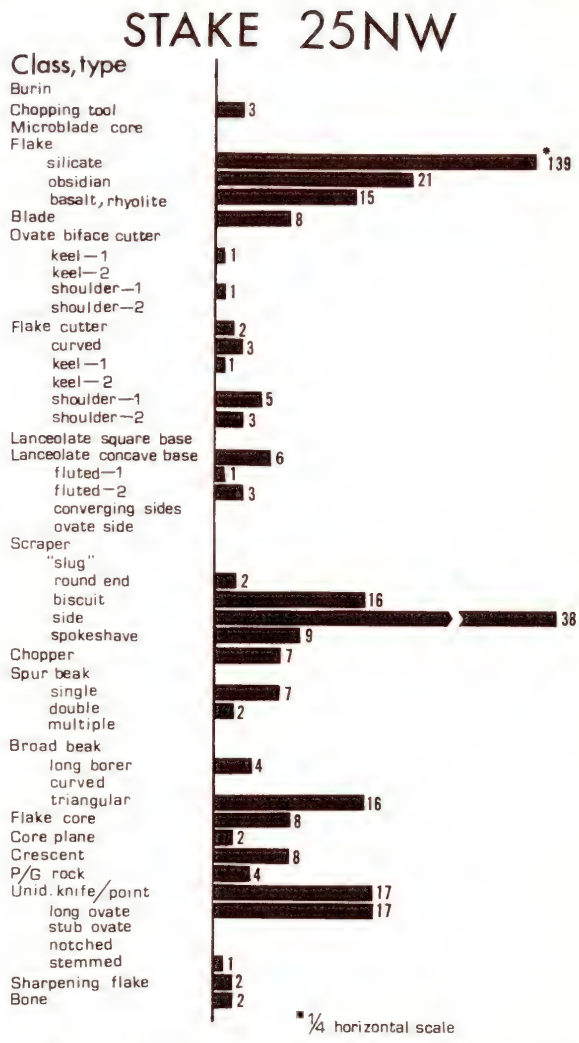


FIGURE 77D. Stake 25NW, histograms of artifact numbers, all Quadrants.

Early peoples who visited, hunted, gathered and worked along the gravel bench were evidently conservative, limited and parochial. They travelled and traded little and were the "locals" with narrow cultural contacts. A good example of this atavistic restriction is the limited range of artifactual stone used by Stake 25NW campers. In contrast, Classic Clovis phase groups in the Basalt Ridge M-184 district used a great variety of raw materials for their tools—the range of jaspers being most striking and meriting a special study that will be undertaken in the next work of the China Lake Program.

Classic Clovis bands appear to have travelled and/or traded widely to acquire the finest of chalcedonies, jaspers and agates. Cultural affiliations of these later peoples had become very broad by comparison with the more restricted lifestyle of foragers at Stake 25NW.

Dates.—Neither soils (which remain to be identified) nor other materials have yet been dated in this locality.

Artifacts.—First, the types of stone used for tools in the Stake 25NW control square are annotated.

1) Rock crystal (four specimens) occurs here. Limited quantities of a good quality crystal also were found on Stake 24 and the M-184 district. The source(s) is unknown.

2) At Stake 25NW, silicate rock predominates over obsidian (Fig. 77D).

3) Amounts of silicates also are higher in proportion to basalts than in later site localities like Basalt Ridge.

4) Jaspers and chalcedonies at Stake 25NW were more altered by time and exposure than at any other stakes. They not only were heavily eroded and sanded but also chemically transformed in a deep surface rind.

5) Evidence of re-use artifacts, which show second and third generations of flaking is common.

6) Very sharp spur beaks, illustrated in Chapter 4, do not appear at Stake 25NW nor other site localities along the bench. Tiny, sharp beaks probably were invented later to meet some change in production and technology.

The beaks at Stake 25NW agree in design features with beaks of the Core Tool Tradition: they are sturdy and snubnosed. Davis suggests that a number of designs of heavy-duty beaks, suitable for burin use, were

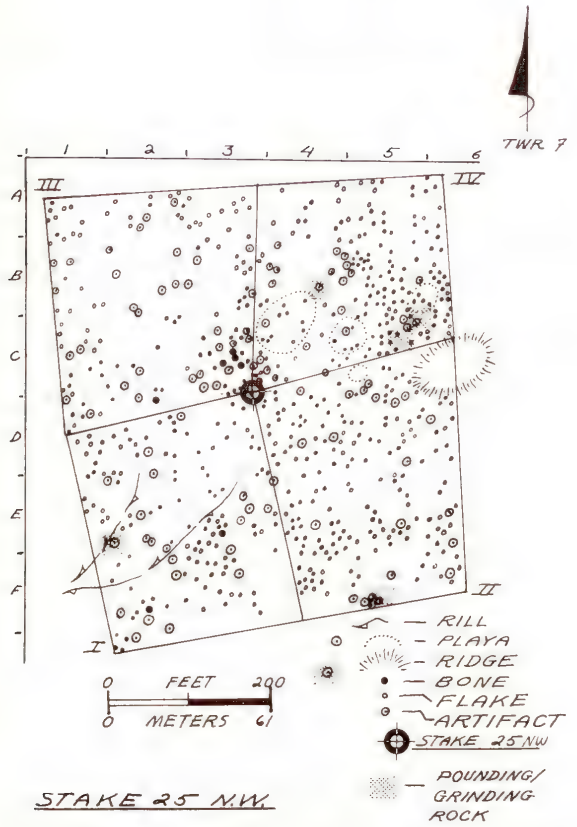


FIGURE 77E. Stake 25NW, total scatter of flakes, artifacts, bones and nests of pounding/grinding rocks (shown as stippled squares).

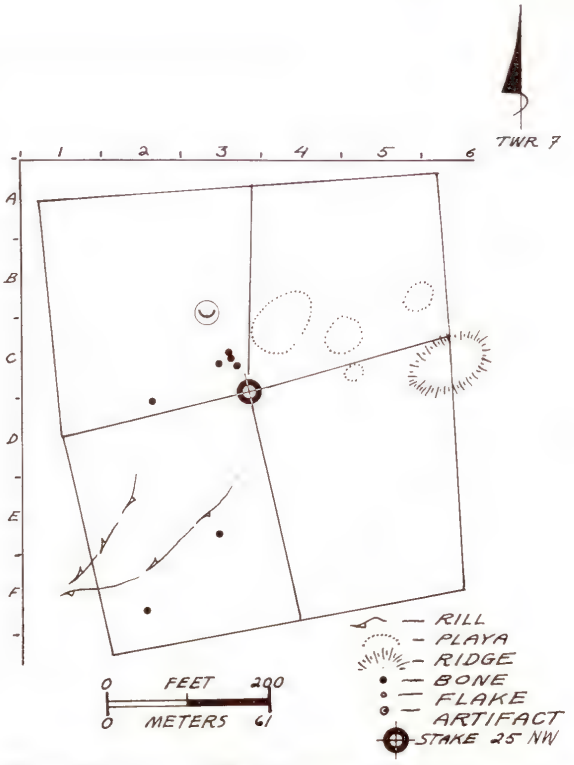


FIGURE 77F. Stake 25NW, distribution of crescents (circled arc).

brought to the New World during the middle Wisconsin (based on observations over the past 15 years in this valley and in Panamint Valley). They were inherited from Siberian tool traditions, and should be found in the earliest North American toolkits.

7) In the Stake 25NW camps, sidestruck flakes are common but blades are also in evidence (8).

8) Crescents (Fig. 77F) are more rare at 25NW (a camp and work locality) than along north-south lines (former beaches?) on the more inclusive Stake 25 strip.

9) Some of the jasper is unusually poor in quality, appearing to have been derived from the Milspaugh Canyon source. This suggests (seasonal?) travel toward the NE, over the Argus Range and into the central and north basins of Panamint Valley.

10) As at other site localities along the high bench, Stake 25NW produced unusually massive choppers and side scrapers, perhaps a tie with the Core Tool Tradition?

11) Some of the PaleoIndian visitors at Stake 25NW made extensive use of microflakes. It was suggested (above) that these may have been hafted in wood or rib. They are too small to be finger-held, but many show use nicks.

STAKE 19SW

Discussion.—Stake 19SW will be the last of the high bench sites needed for a sample of this district. Next, its companion Stake 19 will be described and discussed thereby completing a review of all sites, tests and controls in our mapping program. This chapter will then be tied together with a brief overview of Paleo-Indian land use patterns as we interpret them from the evidence of maps and collections.

Stake 19SW was selected for a particular reason: it was a little plot of surface with an unusual number of singles or nests of pounding/grinding rocks. We wanted to learn more about these amorphous artifacts that appeared to place the miller's arts in the Americas much further back in time than had been previously estimated. We had thought that "PaleoIndian" cultures were Big Game Hunting technologies, which did not rely upon stone-on-stone milling. This is not true.

A long series of ancient peoples, who used Lake China resources as part of their seasonal round, were versatile foragers, skilled in taking large birds and an occasional large herbivore. But most of all they had an encyclopedic knowledge of the entire food list of plateau and upland, marsh and fen. In exploiting these products of nature for equipment and food, they had always used hand stone and anvil stone, singly or together.

Elevation of datum.—2,182 feet MSL.

Situation.—Stake 19SW is the most easterly and lowest of all surveyed loci in the high bench vicinity. It is also related to Stake 19, being only 150 m SW of the SW corner of 19 (see Fig. 74A, a map of all stakes). To the east of Stake 19SW there is an imperceptible lowering of elevation along the wash, described in a previous section. Stake 19SW is well back from the high bench escarpment, lower, downwind and out of sight; a good location for home camps if the occupants expected to hunt or post lookouts along the bench. The unusual number of pounding/grinding rocks (7) made this locus a good candidate for investigation of PaleoIndian camping practices and technology.

Surface deposits.—A reddish gravel mixed with sand overlies 3–6 inches of vesicular silt. Traces of flaggy sandstone on the surface indicate that this locus was associated with one of the Lake China paleosols (G. I. Smith, this volume). Which one of the Upper Wisconsin soils this might have been has not yet been determined. Two backhoe cuts at Stake 25 show that the high bench is stratigraphically different from Stake 24, eastward. As an example, Trench A at Stake 25 contained a blocky marl formation not seen in other trenches.

The Stake 25 bench district merits a special series of archaeology-geochronology studies when we return to the field.

Fauna.—Only a single fragment of unidentified bone was found on this surface, strengthening the identification of this small locus as a place of campsites rather than killsites or butchering sites. Boned-out meat probably was carried back to camp to be eaten or sliced for drying. The toolkit suggests that work was done with manufacturing bone objects but these have long since disappeared.

Cultural activities.—Since this is interpreted as a place of home camp activities, it is most logical to explain the presence of knife/points and crescents in 2 ways: a) they were dropped in camp by returning hunters; b) they were used, for other than their primary purposes because they were handy and then lost. In working with the Hogup Cave collections, Wylie (1975) found that the cave inhabitants had put to work any tool which could reasonably serve their purpose (e.g. points used as knives). We do the same thing (e.g. use a dime to turn a set-screw). Distributions of various diagnostic artifacts over the camps is shown in Fig. 78B.

An inspection of the Stake histogram (Fig. 78C) indicates work with bone, particularly in a single (?) camp NW of the station. This activity is suggested by the presence of beaks and burins. Some of the campers also shaped wood with broad beaks, spokeshaves and choppers; cut meat and skins; smashed bone; processed plant materials for food and manufacture; and possibly made baskets. As one would expect in a home-base campground, work with stone tools was of primary importance—making tools, reshaping old ones and resharpening those which were too dull. Note the proportionally large number of flakes shown in Fig. 78C, a preponderance of them from silicate rather than obsidian cores. Considering the small size of the collection as a whole, the numbers of flakes and flake cores is larger than average. In addition, the presence

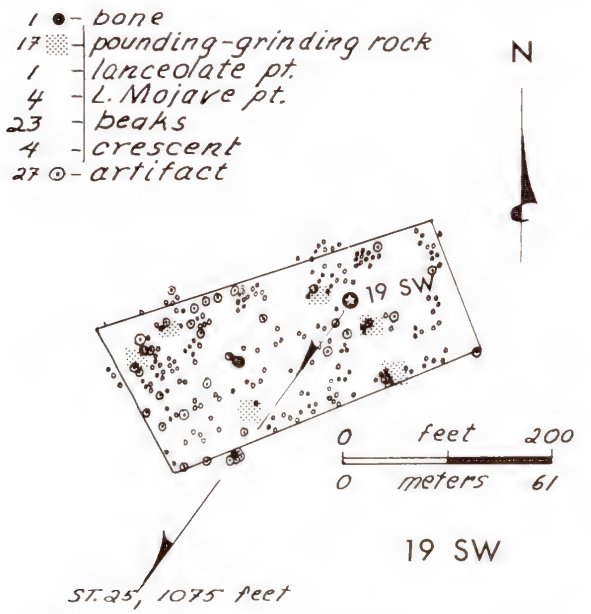


FIGURE 78A. Stake 19SW, showing total scatter of 1 bone, flakes and artifacts, and nests of pounding/grinding rocks marking centers of family camps.

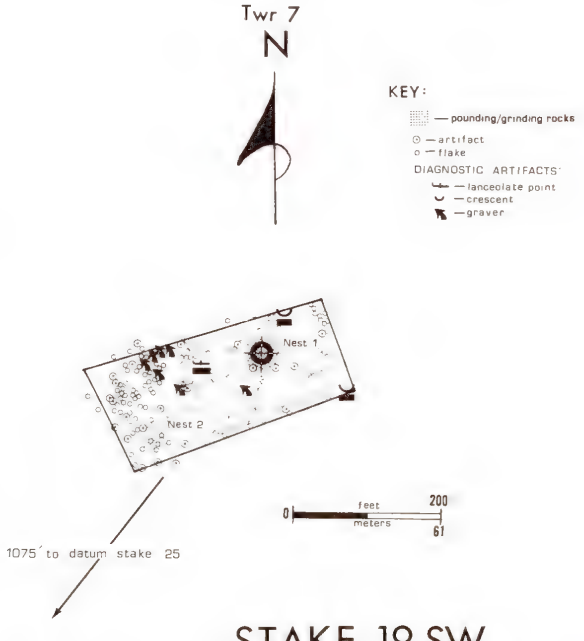


FIGURE 78B. Stake 19SW, with diagnostic tools added: Proto-Clovis knife/points; crescents; beaks (''gravers'').

of two blades is interesting in a group of percussion flaked implements and irregular shaped flake cores.

Paleocultural affiliations.—This camping locus was probably most frequently used by bands with cultures of Late Wisconsin and Proto-Clovis phases.

Artifacts.—Pounding/grinding rocks are of particular interest in these camps and are shown as stippled squares in Fig. 78A. Only six squares are indicated but one contained two specimens, making seven in all. The composition of this Paleolithic milling assemblage is as follows: 2 flat anvils; 2 cobble handstones; 2 fragments; 1 cobble altered as a chopper.

These objects are typical of the all-purpose and unspecialized (but exotic) stones which PaleoIndians packed around in this rockless valley. These amorphous tools are archetypes for increasingly special and diverse milling gear of the ancestral Desert Culture (Jennings and Norbeck 1955) which, in turn formed a Mesoamerican-North American base for the development of agricultural civilizations. In addition to the ancestral milling gear (pounding/grinding rocks), toolkits of Lake China PaleoIndians give us clues to the depth of Paleolithic roots of other archaic traits in the Mojave Desert:

1) Manufacture of fur-string and feather-string robes.
2) Development of basketry (reflected in a few remarkably tiny spokeshaves for sizing wooden splints).

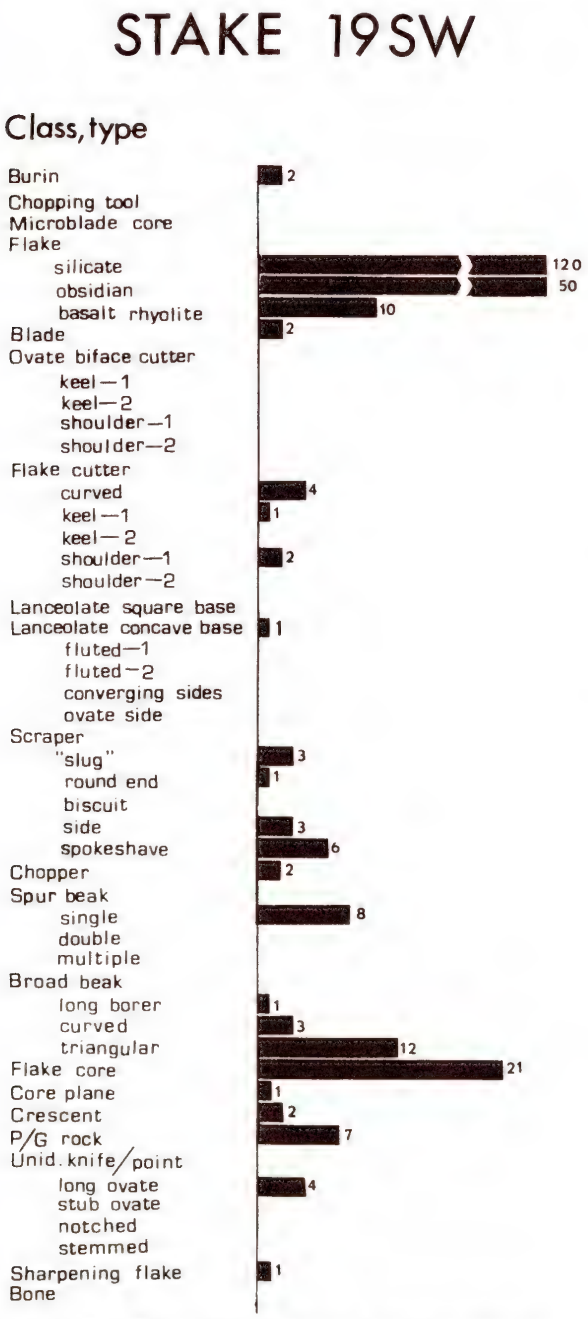


FIGURE 78C. Stake 19SW, histogram of artifact quantities.

STAKE 19

Elevation of datum.—2,178 feet MSL.

Situation.—This locality is slightly downgrade from Stake 19SW and NNW of Stake 24 (Fig. 74A). Most of Stake 19 occupies a meandering drainage described in a previous section. There are two exceptions to this generally low elevation—an island (?) in the SE portion of Quadrant C including the station knoll; and the south border of quadrants A and B (Fig. 79A).

Surface deposits.—Two patches of flaggy sandstone NW of the station mark the former presence of an unidentified paleosol associated with the "island" mentioned above. This imperceptible rise and the south border are covered with reddish gravel, draped over

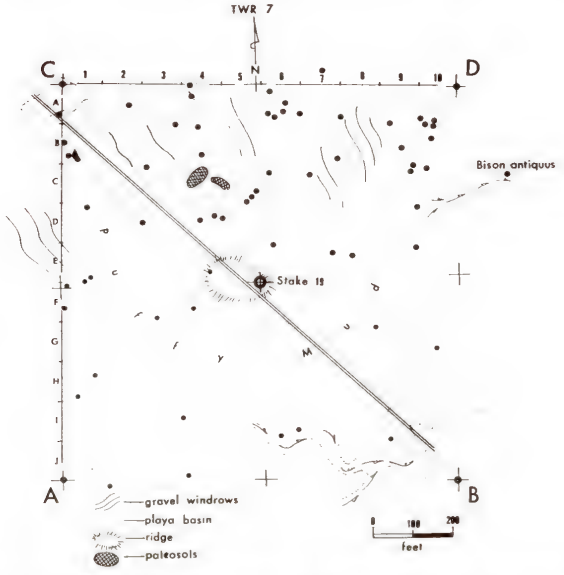


FIGURE 79A. Stake 19, scatter of bones and *Bison antiquus* skull.

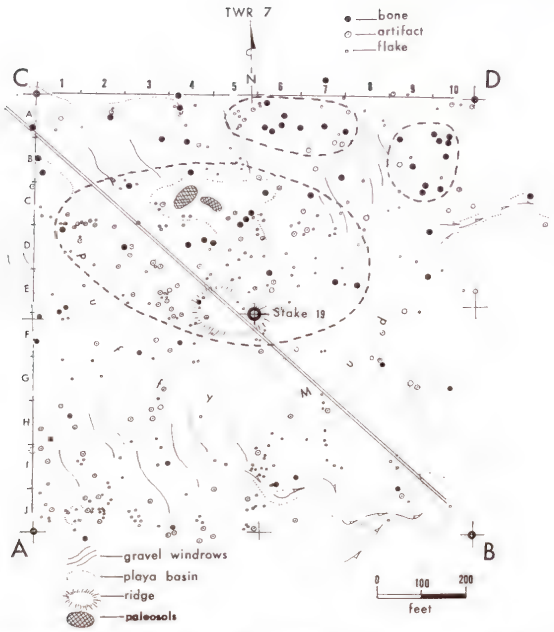


FIGURE 79B. Stake 19, total scatter of artifacts, flakes and bones and suggested groupings including a central island in the slough.

wind-normal windrows in a few places and dotted with little silt playas. Elsewhere, rill action has cut through more recent deposits to old lacustrine clays, now visible as stretches of puffy mud (Fig. 79A).

The bone-artifact relations shown in Fig. 79B support the suggestion of a former topography consisting of a southern shore and an island in a slough.

The paleosol remnants located at B/C-3/5 on the maps are of particular interest since they may be residua of the same soil found near Mammoths nos. 1 and 4 further downstream. We have already suggested that this soil may equate with the Lake Searles BC soil (Smith 1968, Fig. 5) dating between 14,000 and 16,000 years BP.

Fauna.—An inspection of bone distributions shows that the scatter is largely confined to quadrants C and D; also that it is more random than at many other stakes, probably due to water in the channels moving bones about during floods. However, there appear to be three non-random bone arrangements; a line of bone fragments at C/D-3/6 (associated with the island), a small concentration at A-6; and another in B/D-8/10.

The best reason for proposing an association of people and extinct animals in sites along the drainage is the association of both bones and tools with a paleosol. It will be necessary to verify this association at Stake 19 and to identify the particular paleosol involved (see G. I. Smith, this volume).

If the locality were a slough, this would have been a favorable place both for trapping large mammals and hunting large waterfowl (in addition to all the gathering and snaring activities probably associated with a marsh). The presence of the severed *Bison antiquus* skull (with horn cores preserved) a short distance downstream may be associated with human activities. The *Bison* (labelled) can be seen in Fig. 79A. Not many of the bones at Stake 19 was identifiable but included the following taxa:

Taxon	*Identifiable individuals*
Bison antiquus	1
Mammuthus sp	1
Camelidae sp	0 (?)
Equus sp	1
Class AVES (heron?)	1

Cultural activities.—The artifact histograms (Fig. 79C) suggest the following kinds of work:

1) Cutting bone (4 burins).

2) This was predominantly a hunting locality (45 assorted knife/points in this small inventory).

3) Birds as well as large mammals were taken as attested by the presence of 15 crescents—if our hypothesis of the use of crescents for fowling is correct. This hypothesis is certainly reinforced by the Stake 19 correlation of crescents in this (probable) slough situation.

4) Butchering with choppers, a chopping-tool and side scrapers.

5) It is interesting that fine slicing (meat; fur-string; hide) using cutters was largely done on surfaces of quadrants A and B (most apt to have been dry campground) rather than in quadrants C and D, which must have frequently been swampy. The island should also have been dry as indicated by the formation of a soil.

6) Disjointing of animals and work with bone (using spur beaks).

7) *Much* work with wood, indicated by relatively high numbers of saws, spokeshaves and broad beaks suitable for boring.

8) The above tools and a few of the crescents (should be rechecked) also suggest peeling and sizing willow wands and/or roots for twined basketry.

Paleocultural affiliations.—The tool technologies of this locus have a low ratio of correspondence with lanceolate weapon forms and a high correspondence with ovate or ovate-shouldered forms. Preponderance of obsidian in the flake counts (Fig. 79C) suggest that this locus may have been used by peoples who were, culturally, late in time. This view is supported by the presence of eight blades and one microblade core, possibly indicating new arrivals from the North.

Only one knife/point of Lanceolate Tradition (Fluting Cotradition) was found whereas the rest of the weapons are related to various phases of an Ovate Tradition (Western Lithic Cotradition) (Davis et al. 1969). Weaponry of these lineages and their blends are illustrated in the Summary. At Stake 19 there was also a single,

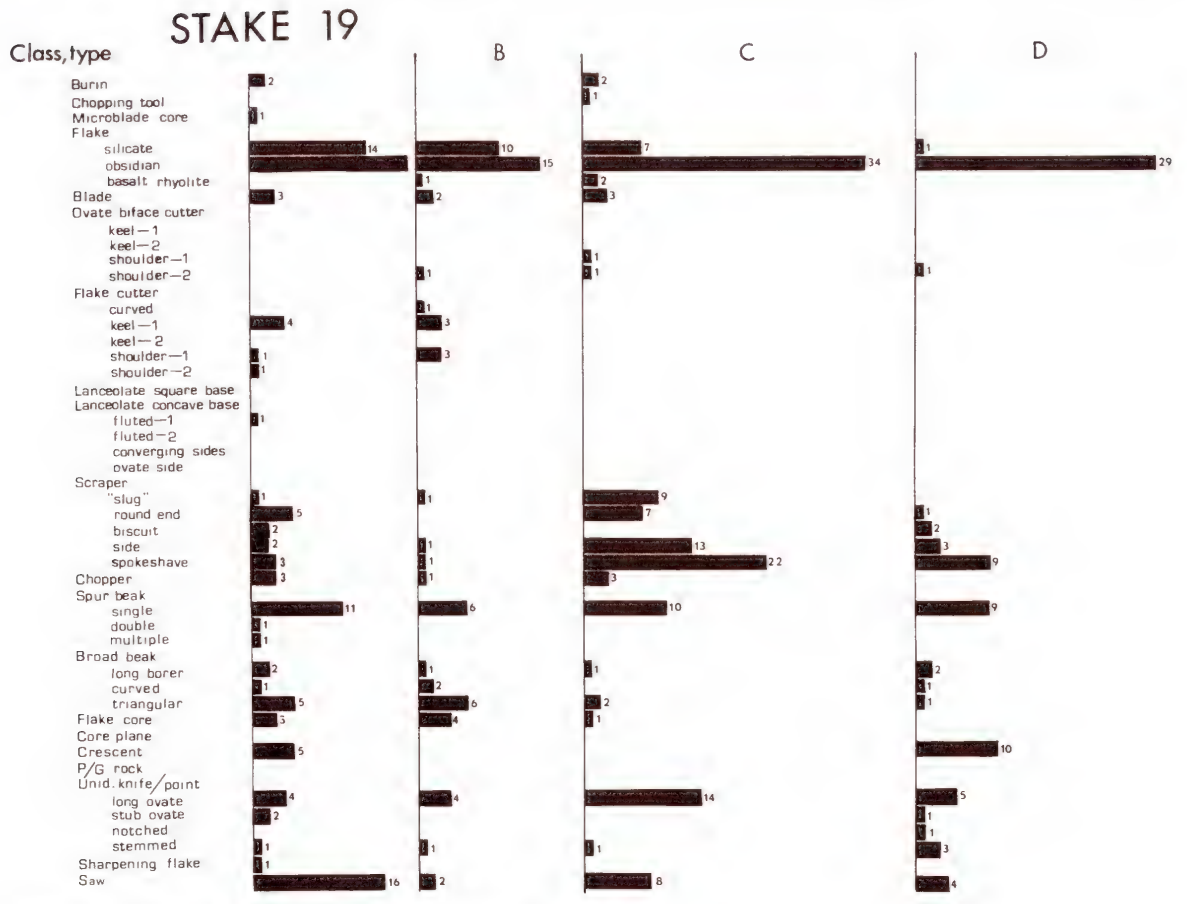


FIGURE 79C. Stake 19, histograms of artifact quantities in Quadrants.

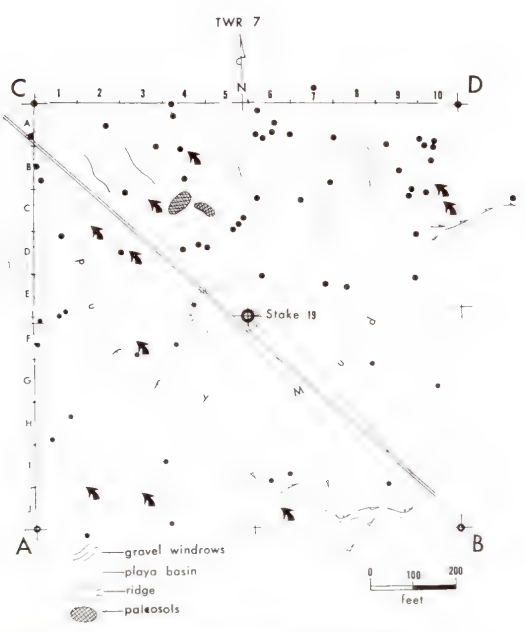


FIGURE 79D. Stake 19, distribution of all beaks.

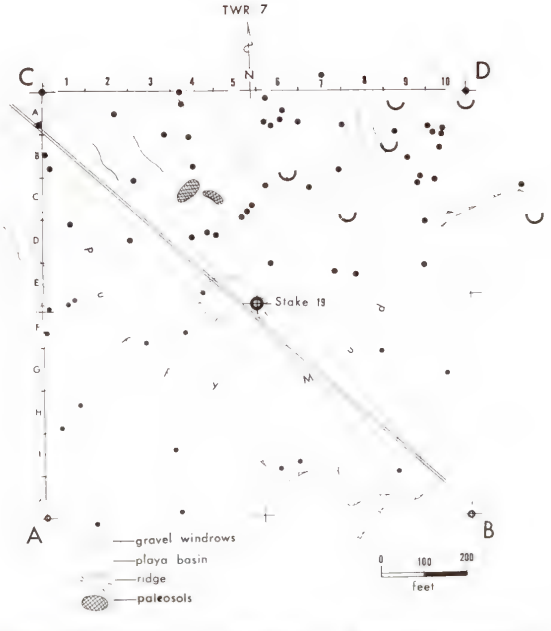


FIGURE 79E. Stake 19, clustering of an unusual number of crescents.

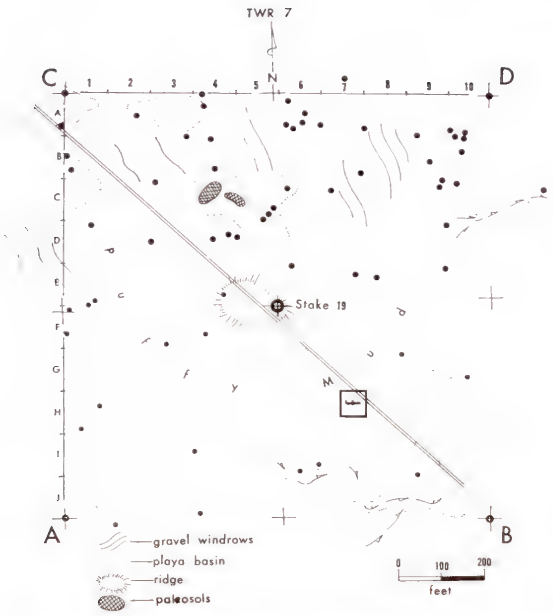


FIGURE 79F. Stake 19, location of a single Fluting Co-tradition knife/point ("Lazy" F in a square).

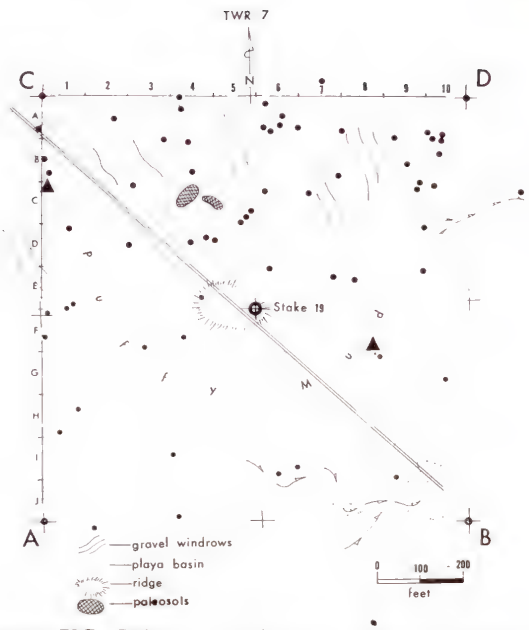


FIGURE 79G. Stake 19, locations of 2 Western Lithic Co-tradition objects.

notched knife/point, attributable to a Pinto Phase. Thus, cultural affiliations at Stake 19 appear to read as follows: a trace of Proto-Clovis: Late Wisconsin Cultures; an undefined Northern Intrusion(?) or other new influences; and Pinto.

Artifacts and discussion.—These have been treated, above, except for a group of diagnostic artifacts with particular distributions which are presented for comparison. Beaks have distributions that relate either to campsites in general or to bone concentrations in particular (Fig. 79D). Crescents (Fig. 79E) are confined to Quadrant D, where they are associated with a still-active wash. The fluted knife/point (Fig. 79F) was possibly washed in from higher up the drainage; this may also be true for the Lake Mojave knife/point (1) (see Fig. 79G).

THE SEASONAL ROUND

"Extraction of economic resources was a significant determinant of the land use patterns practiced by aboriginal inhabitants of the California Desert. Location of archaeological sites, therefore, will have a regular relation to the distribution of economic resources used by the past inhabitants . . ." (Weide 1975:6)

Detailed studies of our plane table maps and of air photographs leaves no doubt that a long squence of early foragers who visited the basin of Lake China on their rounds, were primarily focussed upon the lake (a shallow, reedy lake with mucky shores): upon its tributaries, bays and sloughs. Practices of making seasonal rounds to harvest natural foods of materials, have been amply documented for such Desert Culture peoples as the Shoshone and Paiute (Steward 1933; 1938; Thomas 1971). Extrapolating this custom to PaleoIndians not only is reasonable, but also is supported by information from PaleoIndian sites in the basin of Lake China. This basin was evidently only one of a chain of foraging areas used over the millennia by mobile bands of ancient peoples who relied on seasonal transhumance to ensure themselves a livelihood at all times of the year. This ethnographic extrapolation is reinforced by our site evidence that all artifactual stone (including the pounding/grinding rocks) was packed in from a distance. *The directions of these sources of stone give us compass heading to the avenues of repetitive migrations.*

Once a band had arrived in the valley (which they probably knew intimately), their choices of a base camp could be summarized as follows, in order of desirability. First, well-drained knolls with an overview, adjacent to a marsh/grassland interface along which they could harvest foods and products of both biomes, adding an occasional large herbivore for camp meat. The Stake 25 high bench (Fig. 80A, Site 1) is a good example. Second, a stretch of lake or marsh frontage, *not* close to pasture lands, but offering special (although unknown to us) foods and products. This sort of site decision is illustrated by Transect B, Site 3, previously described. Third, a choice exemplified by the Henry Site (see Fig. 80A). This might have been selected opportunistically, on the spur of the moment, because animals were sighted close to a natural trap into which they could be stampeded. A fourth type of site decision (evidently later in time than the others)

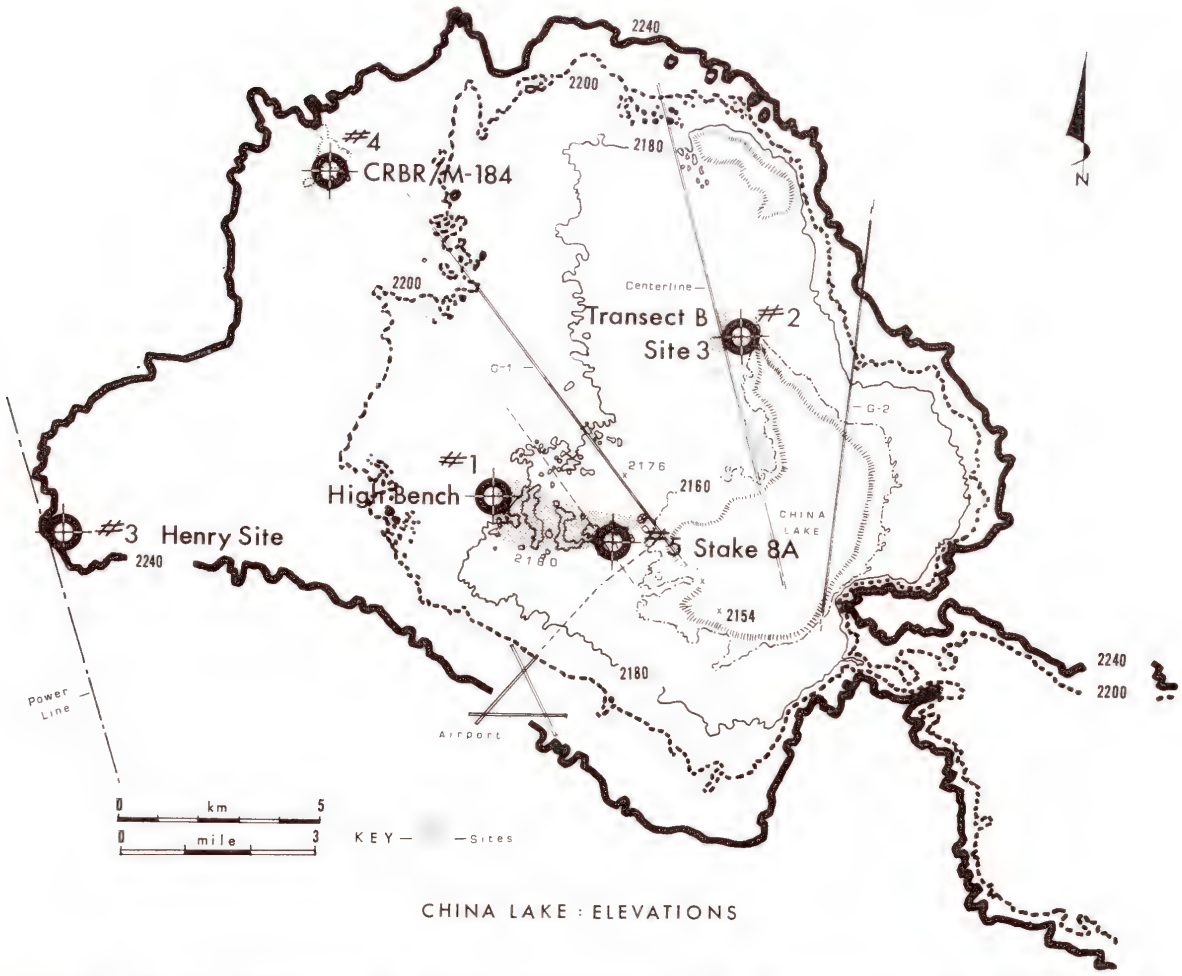


FIGURE 80A. The valley of Pleistocene Lake China showing the relation of 5 Case Study localities with different Land Use Patterns, and their positions at different levels of the lake.

is the Basalt Ridge M-184 district. This is determined by a nearly high stand of the lake, which had just receded from brimful, a stage when tufa had been deposited for a final time on the Basalt Ridge. A fifth choice was for some kind of specialty task locus (see below). These various kinds of living strategies and their spatial arrangement are shown in Fig. 80A. They will be further discussed as five Case Studies, below.

Controls of Site Decisions; a) Non-cultural

1) Water level of the lake was the primary determinant of choice. Distribution of this site sample shows that people followed the shorelines back and forth as the lake fluctuated.

2) Presence and suitability of grazing lands for such large herbivores as mammoths, camels, horses and bison.

3) Proximity of potable water.

4) Proximity of marsh areas for three purposes; a) as traps for large animals; b) for foods; c) for industrial plant products.

Controls of Site Decisions: b) Cultural

1) Time period.

2) Group size and regional population density (assumed to have been small and sparse until the Classic Clovis phase).

3) Life style of the group (religion, traditions, interpretations and cultural values).

4) Level of social organization.

5) Level of technological complexity.

6) Cultural interpretation of women's and men's work. This latter is discussed in Case Study 5 (Stake 8, Quadrant A SW).

Five Case Studies are presented below as examples of land use.

Case 1.—The high bench vicinity near Stake 25 (Fig. 80B) is an example of a site decision evidently controlled by a number of factors: a relatively high stand of the lake at about 2,180 feet (664.46 m) MSL: grazing lands upwind and dry campsite downwind of a large pond; an overview of the grasslands; adjacent water (and undoubtedly marsh) associated with the pond. This was a hunting, home-camp and processing locality.

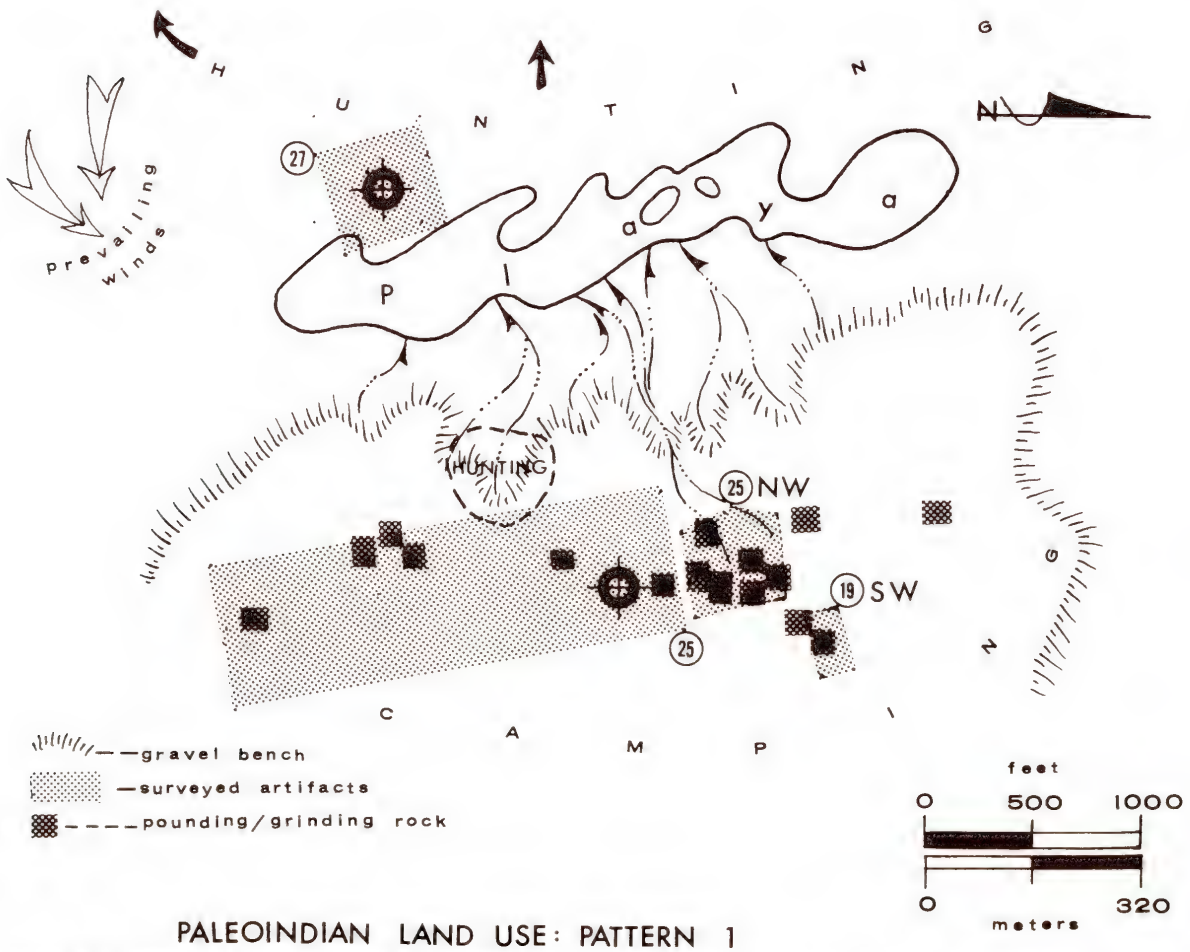
Case 2.—Transect B Site 3 appears to have *not* been a locus where the inhabitants emphasized hunting large mammals or birds. It is interpreted as a series of camps for marsh foraging: snaring smaller birds and muskrats, gathering eggs, frogs and nestlings. Plant foods and vegetal industrial products were probably of major importance. Among other camp activities, fur-string for robes, matting and basketry were probably made.

When this low-elevation locus was in use, the lake stood at a level of about 2,160 feet (658.37 m) only slightly higher than today. The locality was selected for the following reason: a) it was between two seasonal washes (of fresh water?); b) the lake was undoubtedly brackish but capable of supporting a marsh (which it does even today).

At the time when this shore of a retreated lake was used, other subsistence areas in the valley may have been drastically curtailed; the grasslands shrunken and large grazing animals under pressure and diminishing in numbers. This was the most easterly site shown in Fig. 80A.

Case 3.—The Henry Site (Fig. 80A) is entirely isolated and appears to have been occupied only once. Its selection may have been a quick, opportunistic choice by a small band of not more than a dozen individuals. The band evidently killed a horse and a camel in an advantageous trap locus provided by a bay or slough (a faint shoreline is still visible), after which they built two shelters and settled in for a brief time, devoting themselves to meat cutting with unmodified flakes of obsidian.

It is interesting that the only recognizably shaped tool in a collection of less than 50 specimens was a



PALEOINDIAN LAND USE: PATTERN 1

FIGURE 80B. PaleoIndian Land Use Pattern #1, showing relation of camping vs. hunting territories to position of a large pond and the prevailing winds.

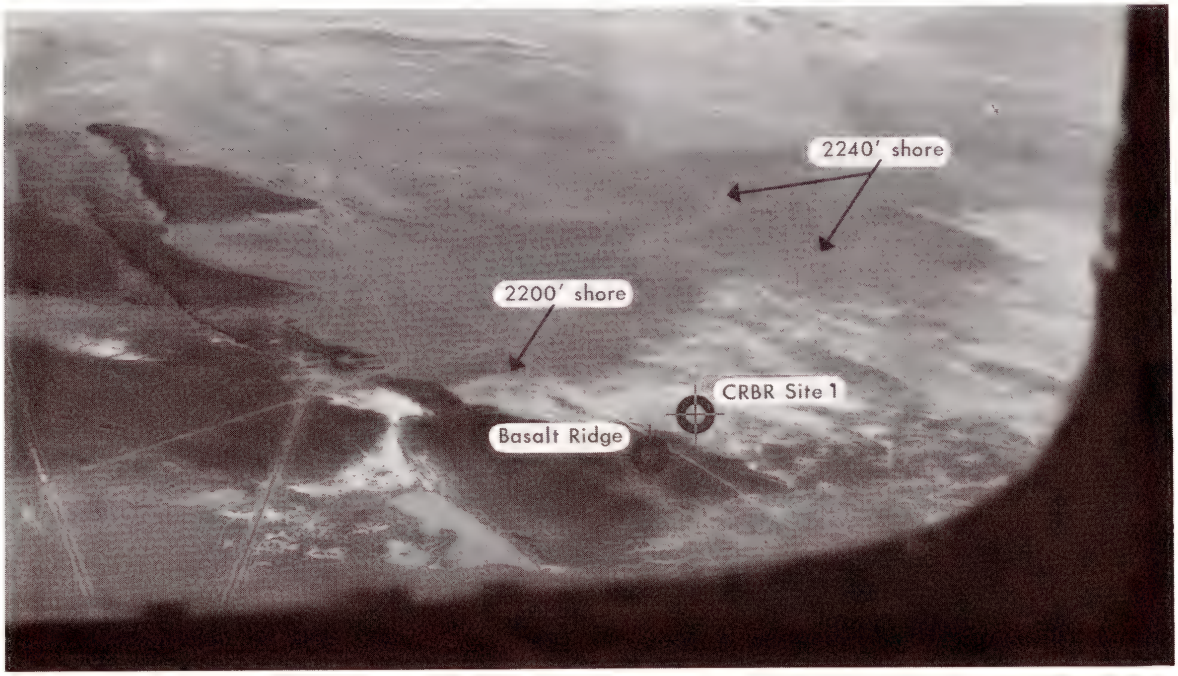


FIGURE 80C. The Basalt Ridge: master datum for CRBR (and also the M-184 district to the south). View looking NE past Airport Dry Lake and the White Hills. The embayment which dominated choice of the Classic Clovis kill sites can be clearly seen in the center.

bifacial, stemmed knife/point. Because the locus may have been determined by the presence of a small bay or sluggish stream, it may also have been in use during a late interval when Lake China was at maximum height of water and valley-center camps were unavailable (refer to the site description, earlier).

Case 4.—Basalt Ridge M-184 is actually a whole district of large, although undetermined, extent and is the most northerly of the site clusters tested by us (Fig. 80A). Within this district, only Basalt Ridge Site 1 has been mapped and test excavated. Site 1 produced an extraordinary number of flakes, tools, teeth and bones of all manner of animals from mammoths through camel and horse to fish, shore bird and vole. These remains are distributed in a line along the south shore of a shallow bay (Fig. 80C).

The Basalt Ridge bone bed and butchering localities saw most of their action at a late period when Lake China was receding from a last high stand (during which a second tufa deposit had formed on the Basalt Ridge above). The date on this second tufa is 12,200 ±120 radiocarbon years BP UCLA-1911 B. This date is probably 500–1000 years too old.

At this period, the Basalt Ridge locality was visited by rather large bands of people, possibly comprising as many as 50 individuals who were able to form aggressive, successful hunting teams and organize subsequent butchering and meat slicing for maximum retrieval. Technologically and socially, these folk belonged to a Classic Clovis phase. During this lake-side episode in their seasonal round, their focus was the

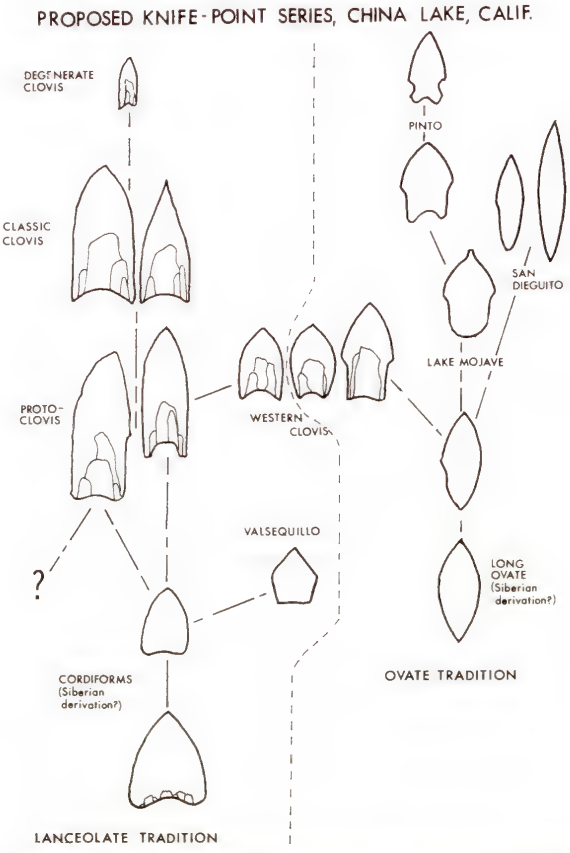


FIGURE 81. An illustration of technological traditions of knife/point design, as they changed and merged over time in Lake China basin.

FIGURE 82. The Lakes Country. Heavy arrows show proposed population drift following expanding grasslands in those areas which became the Great Plains.

swampy bay which they used as a trap. This bay can be seen in the center of figure 80C, a hand held photograph shot from a light airplane. Taken after heavy rains, this picture shows some of the ponds at lower left filled with water. There is also a shoreline at about 2,205 (?) feet (672.00 m) MSL, etched by Lake China during Classic Clovis use of Basalt Ridge resources. This shore meanders from the bay toward the upper right side of the photograph, giving an excellent view of the setting in which Classic Clovis intensive hunting took place: the lake was very high although receding from full. A higher shore at 2,240 feet (682.75 m) MSL can be seen faintly, just above the Clovis shoreline (Fig. 81).

Case 5.—The SW corner of Stake 8, Quadrant A was previously described as having possibly been a Women's Work Locus. This suggestion is based on the smallness of the site; its isolation; the scarcity of male tools; and the fact that the toolkit in this small space appeared to be an archaeological unit made up predominantly of small, fingerheld, multipurpose implements for peeling, shaving, sizing and scribing.

If this interpretation is correct, then a little group of women took off for the day from some nearby, family camp and were evidently at work near a moist area (with willows?), busied with shaping soft, woody materials and hide. These tools are attributable to a Late Wisconsin Culture or Proto-Clovis phase and were used at s time when the lake level stood at about 2,170 feet MSL.

Kill and butchering practices as related to land use.—In the Lake China valley, Fluting Cotradition knife/points (Davis et al. 1969) do not appear to have been used for killing. During early phases, this was probably done with sturdy bipoints of Ovate Tradition and by Classic Clovis times, bone harpoons or a special, fluted point with a needle-sharp tip may have taken their place. *Lake China mammoths have only been found with choppers.* There is a possible and much vaguer connection with crescents.

Carcasses appear to have been processed as follows: large animals were driven into a bog and killed. Then all retrievable portions (not buried in mud) were dismembered on the kill, using pounding/grinding rocks; choppers or chopping-tools; side scrapers and knife/points. Large sections were then *carried* or *rolled* (a whole mammoth head, for instance) to a butchering station on the nearest dry land. Here, the brain was removed and carried to camp (where the entrails were already being processed and eaten) while the muscle meat was being boned out in large blankets, using knife/points, side scrapers and ovate knives (bifaces).

Some meat was thin-sliced for jerky on the spot; some was taken over to camp which had been set up after the kill. This camp meat was, in some cases, not boned (a tasty morsel like a camel head or a haunch of horse). This hypothetical reconstruction accounts for the large amounts of bone found at kill sites and the smaller amounts of smashed bone in camps (Fig. 82).

Chapter 6

HOLOCENE HISTORY OF LITTLE LAKE, MOJAVE DESERT, CALIFORNIA

By Peter J. Mehringer, Jr.[6] and John C. Sheppard[7]

A Lake's History

ABSTRACT: Dated sediments and fossil pollen, seeds and molluscs from an 11.3 m core provide evidence for the water budget of Little Lake, Inyo Co., California, for the past 5000 radiocarbon years. The spring-fed lake basin, in the channel of the Pluvial Owens River, has had a dynamic Holocene history. From 5000 to 3000 BP the sediments and fossils primarily represent salt grass meadow and marsh deposition. After 3000 BP the basin was occupied by a shallow lake, but there is no clear evidence that the lake was much deeper or fresher than during the past few years. Lake history records past water availability that may contribute to our understanding of Holocene climatic change for the northwestern Mojave Desert.

HOLOCENE HISTORY OF LITTLE LAKE

INTRODUCTION

During the last pluvial period, about 22,000 to 12,500 years ago, the Mojave Desert was a region of xeric woodland and cold steppe (Mehringer 1967a,b; Mehringer and Ferguson 1969; Wells and Berger 1967) surrounding deep lakes and fertile marshes, and their connecting streams and rivers (Snyder, Hardman and Zdenek 1964). It supported the last of the extinct Pleistocene megafauna and perhaps man as well. By 7,000 radiocarbon years ago the climate of the northern Mojave Desert was probably similar to the present and more arid than anytime during the preceding 20,000 years. However, the period of most dramatic postpluvial climatological, biological and archaeological changes occurred within the first few thousand years following the last maximum lake levels. It is during this time that there is clear evidence for coexistence of man and extinct megafauna, possibly to the detriment of the latter, and the rapid retreat of extant biota northward and to higher elevations. It is also a time when Davis (1975) believes that the recessional shorelines of China Lake Basin served as campsites for people utilizing the resources of ephemeral ponds and marshes. Similar claims have been made for other ancient lakes of the Mojave Desert (Ore and Warren 1971).

These events associated with the waning phases of the last pluvial drew our attention to Little Lake. Our primary goal was to date the last overflow of Owens Lake, via the Owens River, to Searles Lake (Figs. 83 and 84). Since Little Lake occupies the former channel of the Pluvial Owens River, we assumed that, with exceptional good fortune, cores from Little Lake would penetrate to river gravels and radiocarbon dates immediately above these gravels would provide a minimum age for the river. Such dates would be important in limiting the age of minor lake fluctuations in the China and Searles basins and of archaeological sites around them. There were other equally important reasons for studying the history of Little Lake.

Little is known about the postpluvial paleoecology of the Mojave Desert, primarily because continuous and well-preserved fossil records in association with stratigraphically controlled radiocarbon dates are rare. However, as illustrated by studies of the Amargosa and Las Vegas valleys, Nevada (Haynes 1967; Mehringer 1967a; Mehringer and Warren, in press), desert spring and lake deposits may provide fossil records equivalent to those of the peatbogs of more humid regions. Such sites are unusual in the Mojave Desert, but since Little Lake had never been completely dry within the memory of local residents we believed it could be one of these. Also, it is located in a transition region from the more xeric Indian Wells Valley to the

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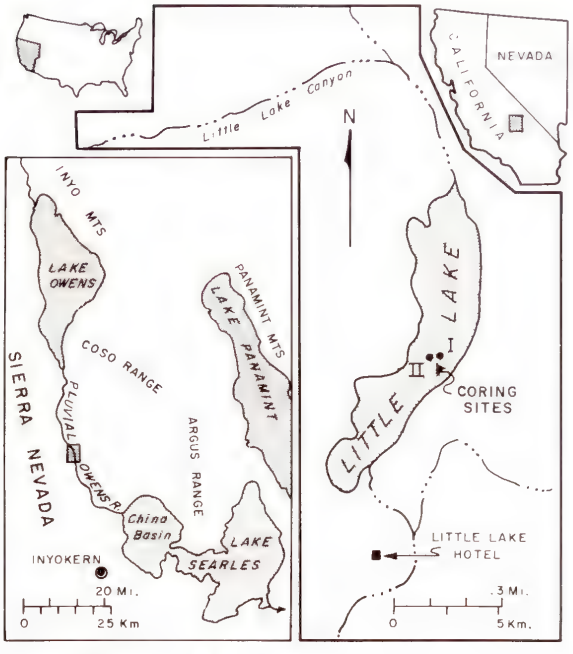


FIGURE 83. Map of the study area.

Owens Valley, at an elevation between the extremes of creosote bush and sagebrush desert at that latitude, and just a few kilometers south of the northwestern limits of the Mojave Desert. Therefore, we assumed that cores from Little Lake would provide a datable, unbroken and sensitive record of past terrestrial and aquatic biota. In short, Little Lake seemed to offer the potential for establishing a regional environmental history as well as information about Holocene biogeography and past resource availability for the aboriginal inhabitants. Little Lake was a historic Shoshoni camp and is an important archaeological locality (Steward 1938:85; Harrington 1957).

For several reasons our initial expectations were not entirely fulfilled. Most importantly, we did not reach deposits of the Pluvial Owens River as impenetrable gray clayey silt, about 5,000 radiocarbon years old, was encountered at 11.28 m depth. Radiocarbon dating, far from proving simple, provided an additional study as "old" bicarbonates gave living submerged aquatic plants apparent ages of several thousand years. Deposition rates were more rapid and the sediments more variable than anticipated. However, in combination with their fossil plants, the sediments proved to be sensitive indicators of lake history.

While the regional paleoenvironmental implications of the Little Lake record remain uncertain and our initial objective of dating the last overflow of Owens Lake has not been met, study of the Little Lake cores has revealed a complex Holocene history of water availability and aquatic environments for Little Lake itself. We report that history here.

STUDY AREA

Little Lake occupies a north-south gorge eroded into columnar basalts within the channel of the Pluvial Owens River. The lake is dammed at the south end by alluvium derived from both sides of the canyon (Fig. 85). This alluvium obscures part of the pluvial river channel. Granite outcrops, partially covered by basalt and alluvium, occur in the vicinity of the dam. A major fault parallels the lake and crosses the drainage below the outlet (Jennings, Burnett and Troxel 1963).

FIGURE 84. Channel of the Pluvial Owens River (June 12, 1974). The photo was taken from Little Lake, core locality II, and shows lake-edge sedge and cattail marsh. Red Hill, a Quaternary volcanic cone 4.8 km to the north, rises 180 m above the surrounding surface.

Springs provide most of the water and loss is primarily by evaporation and underflow to Indian Wells Valley (Dutcher and Moyle 1973:3; Lee 1913). When Little Lake is full, water is also lost by seepage and minor surface outflow. The high water mark of white carbonates on the dark basalts indicates a recent maximum depth of about 2 m. On June 10, 1974 maximum water depth was 1.22 m. Little Lake Canyon, which heads to the west in the Sierra Nevada and is usually dry at Little Lake, provides surface inflow following unusually heavy rain and snow melt.

The mean annual precipitation at Little Lake (965 m elevation) is about 5 inches (125 mm), judging from the 50-year weather records for Haiwee, California (1165 m elevation and 22 km to the north), and temperature and precipitation maps (Elford 1970). More than half of this normally falls as rain from December through February. Mean temperatures for January and July are

FIGURE 85. Air photo of Little Lake (U.S. Geol. Survey, Sept. 30, 1948). The photo shows drainages, from both sides of the canyon, that have provided alluvium that buries the former Pluvial Owens River channel and contributes to the dam for Little Lake (see Fig. 83 for scale).

FIGURE 86. Little Lake (June 13, 1974; view to the south). *Scirpus robustus* and *Typha latifolia* are conspicuous in the foreground. The polygonal cracks that form in the seasonally dry, calcareous sediments between the open water and the marsh are believed responsible for the subangular blocky structure encountered in the cores.

FIGURE 87. Salt grass meadow at Little Lake (June 13, 1974; view to the east). *Anemopsis californica* (in bloom) and *Nitrophila occidentalis* are mixed with salt grass in the foreground; the tree is a willow.

FIGURE 88. Basalt flats west of Little Lake (June 13, 1974; view to the north). The eolian sediments accumulated on the basalt support vegetation dominated by saltbushes and wild buckwheats. The photo shows distribution of marsh and the seasonally dry lake-edge.

about 40 and 84° F (15 and 29° C). Evaporation loss from Little Lake is unknown, but judging from Owens Lake data (Dub 1947), annual pan evaporation probably approaches 100 inches (2.5 m).

The submerged aquatic vegetation is dominated by *Chara* sp., that forms a dense mat 5 to 10 cm thick over most of the lake bottom, and by *Potamogeton pectinatus*. *Ruppia maritima* is also present but less conspicuous. The common lake-edge marsh species include cattail (*Typha latifolia*) and sedges (*Scirpus robustus, S. olynei, S. acutus* and *Eleocharis rostellata*). Salt grass (*Distichlis spicata*) meadows occupy moist ground of seasonally flooded or high water table areas shoreward from the marshes (Figs. 86 and 87). *Anemopsis californica, Nitrophila occidentalis, Juncus* sp. and *Heliotropium curassavicum* are common associates.

A few willows (*Salix* sp.) and introduced tamarisks (*Tamarix pentandra*) grow below basalt cliffs west of the lake (Fig. 87), and mesquite trees (*Prosopis juliflora*) occur about 1 km to the north. Wild buckwheats (*Eriogonum fasciculatum, E. inflatum, E. nidularium* and *E. maculatum*) and saltbushes (*Atriplex canescens* and *A. confertifolia*) common on the thin soils of basalt flats west of the lake (Fig. 88), give way to creosote bush (*Larrea divaricata*) and bursage (*Franseria dumosa*) on alluvial slopes.

METHODS

In July 1970 E. L. Davis, C. V. Haynes and P. J. Mehringer tested the Little Lake sediments from a boat. Although the sediments varied with depth for the first 1.5 m, they were too hard to core further with a hand-operated 5 cm-diameter piston corer. We returned (June 9–13, 1974) with a 10 cm-diameter mechanically driven piston corer. A raft was constructed and a 4 m tower attached thereto (Fig. 89). Cores were obtained in 2 m plastic barrels (Carlon house lead lateral PVC) which were sawed to the length of recovery, about 1.6 m average per drive, and capped. The sealed barrels and contents were placed in cold storage upon their return to Washington State University. Immediately prior to description the cores were exposed by cutting the barrels lengthwise. In this manner the sediments were protected during the transport and not distorted by extrusion.

The top 20 cm or so of sediments were very loose. In order to preserve them for sampling a short (1 m) core was taken at the conclusion of all other coring, kept in an upright position and frozen. The frozen core was sampled while still cohesive but soft enough to cut.

Two cores were collected from near the center of the lake where the channel was constricted by tall basalt cliffs so that coring would penetrate lake deposits in an area of former high water velocity and deep scour within the channel of the Pluvial Owens River (Figs. 83 and 85). Core I was collected in 0.96 m of water (Fig. 89). Core II was taken about 50 m to the west in water 0.87 m deep. Since Core II was more completely recovered and went to slightly greater depth it provided the sediment description and constant volume samples for fossil pollen and sediment studies. Some radiocarbon samples were removed from Core I when they could be correlated to Core II by similar depth and distinctive sedimentary sequence.

Constant volume samples (8 cm^3) for microfossil, mechanical and chemical analysis were collected on the average of every 8.5 cm; actual sampling was determined by depth and stratigraphy. The sediment cubes

FIGURE 89. Little Lake core locality I (June 11, 1974; view to the southeast).

(2 cm on a side) were removed from the core with thin wire stretched over a measured frame similar to a cheese cutter (Kolva 1975, Fig. 6).

Pollen extraction generally followed Mehringer (1967a:137); the samples were acetylized and mounted in 2000 centistokes silicone oil. To estimate the number of microfossils/cm^3 and /gm of sediment five commercially prepared tablets, each containing 12,500 ±500 *Lycopodium* spores (Stockmarr 1971, 1973), were added to each sample in weak HCl as the first extraction procedure. The record of aquatic vegetation was provided by preliminary analysis of 40 pollen samples and the notation of plant macrofossils.

THE SEDIMENTARY RECORD

For convenience of discussion the data derived from the cores are artificially separated and radiocarbon dating is included in another section. However, the biological, geological and chronological evidence are inseparable in the final environmental interpretation. Excepting the distribution of aquatic pollen, the biological and geological data upon which our interpretations are based are included in the core log (Table 14).

The 11.28 m Little Lake core is primarily composed of soft, colloidal, elastic, amorphous and calcareous *Chara* ooze of relatively uniform macroscopic consistency and texture but of variable color. The *Chara* ooze contains identifiable oogonia and fragments, including hard, calcareous coarse silt and fine sand size *Chara* detritus. Exceptions to the structure and consistency, the presence of abundant *Chara* detritus and oogonia, and calcareous *Chara* fragments 2 mm or larger are noted in the core description. Many divisions within the *Chara* ooze were distinguished solely by their differing Munsell colors (moist).

Snails and seeds observed while logging and sampling are indicated as present, common or abundant. The seeds are further identified to genus. Humic, fine peats, lacking conspicuous, identifiable, autochthonous macroscopic plant remains, excepting *Typha* roots, occur below 5.70 m. All large (0.5–2.0 cm wide), partially preserved and flattened roots are called *Typha* because macroscopically they resemble *Typha* roots. However, some other large emergent aquatic such as *Scirpus acutus* may also be represented.

Excepting some peat layers, the entire core contains carbonates as determined by effervescence in dilute HCl. Vesicular carbonate nodules occur in some levels; if they are abundant or 2mm or larger they are included in the core description. Silt size calcareous fragments are common through most of the core; if they are absent or abundant they are also noted in the description.

The distinctness and topography of the lower boundary of each unit are indicated by *Soil Survey Manual* (1951:139) abbreviations. However, the measurements for boundary distinctness differ as follows: very abrupt (<1 mm), abrupt (1–2 mm), clear (2–4 mm), gradual (4–8 mm), diffuse (8–16 mm).

CHRONOLOGY

Initial dating of the organic fraction of the *Chara* ooze produced results considerably older than antici-

TABLE 14

Description of Core II, Little Lake, California

Depth (meters)	Description
0.00–0.66	*Chara* ooze; olive gray (5Y 4/2); slightly sticky, nonplastic, dispersed, vesicular carbonate nodules to 2 mm; rootlets abundant; snails, and *Ruppia* and *Potamogeton* seeds present; dw.
0.66–0.70	*Chara* ooze; very pale brown (10YR 7/4); dw.
0.70–0.74	*Chara* ooze; reddish brown (5YR 5/4); dw.
0.74–0.77	*Chara* ooze; mottled reddish brown (5YR 5/4) and dark reddish gray (5YR 4/2); gw.
0.77–0.81	*Chara* ooze; very pale brown (10YR 7/4); cw.
0.81–0.82	*Chara* ooze; reddish brown (5YR 5/4); cw.
0.82–0.88	*Chara* ooze; very pale brown (10YR 7/4); dw.
0.88–0.98	*Chara* ooze; light reddish brown (5YR 6/4); cs.
0.98–1.01	*Chara* ooze; reddish brown (5YR 5/4).
1.01–1.03	Core not recovered.
1.03–1.09	*Chara* ooze; light reddish brown (5YR 6/4); *Chara* fragments to 3 mm abundant; gs.
1.09–1.17	*Chara* ooze; reddish brown (5YR 5/4); *Chara* fragments to 3 mm abundant; ds.
1.17–1.21	*Chara* ooze; dark reddish brown (5YR 3/3); *Chara* fragments to 3 mm abundant; cs. C-14 date at 1.17–1.25 m
1.21–1.25	*Chara* ooze; dark reddish brown (5YR 3/2); 5 mm light yellowish brown (10YR 6/4) band at 1.22 m; snails present; gs.
1.25–1.29	*Chara* ooze; light brown (7.5YR 6/4); cs.
1.29–1.43	*Chara* ooze; light olive gray (5Y 6/2); 4.5 cm light brown (7.5YR 6/4) band at 1.34 m; cs.
1.43–1.47	*Chara* ooze; light brown (7.5YR 6/4); *Chara* fragments to 3 mm abundant; cs.
1.47–1.51	*Chara* ooze; reddish brown (5YR 5/4); *Chara* fragments to 3 mm abundant; cs.
1.51–1.54	*Chara* ooze; brown (10YR 4/3); *Chara* fragments to 3 mm abundant; gs.
1.54–1.65	*Chara* ooze; olive gray (5Y 5/2); snails present; di.
1.65–1.69	*Chara* ooze; pink (5YR 7/3); gs.
1.69–1.71	*Chara* ooze; light brown (7.5YR 6/4); cs.
1.71–1.76	*Chara* ooze; pink (5YR 7/3); cs.
1.76–1.78	*Chara* ooze; brown (10YR 4/3); cs.
1.78–1.83	*Chara* ooze; light brown (7.5YR 6/4); 1 cm pink (5YR 7/3) band at 1.81 m; cs.
1.83–1.85	*Chara* ooze; brown (10YR 4/3); 4 mm reddish brown (5YR 5/4) band at 1.84 mm; *Ruppia* seeds present; gs.
1.85–1.89	*Chara* ooze; light brown (7.5YR 6/4); *Scirpus* and *Ruppia* seeds present; *Chara* oogonia abundant; cs.
1.89–1.91	*Chara* ooze; light olive gray (5Y 6/2); vesicular carbonate nodules to 1 mm; *Ruppia* seeds present; cs.
1.91–1.99	*Chara* ooze; pink (5YR 7/4); cs.
1.99–2.02	*Chara* ooze; reddish brown (5YR 5/4) with discontinuous pink (7.5YR 8/4) lenses; cs.
2.02–2.05	*Chara* ooze; pink (5YR 7/3); silt size calcareous fragments abundant; cs.
2.05–2.19	*Chara* ooze; 1–7 cm reddish yellow (7.5YR 6/6) and reddish brown (5YR 5/4) bands; 1 cm brown (10YR 4/3) lens at 2.09 m; snails present; gw.
2.19–2.28	*Chara* ooze; 3–5 cm black (10YR 2/1), brown (10YR 4/3), yellowish brown (10YR 5/4) and pink (5YR 7/3) bands; *Chara* fragments to 2.5 mm common; snails present; cs.
2.28–2.33	*Chara* ooze; pink (5YR 7/3) grading upward to pink (5YR 7/4); *Chara* oogonia abundant; cs.
2.33–2.37	*Chara* ooze; yellowish brown (10YR 5/4) grading upward to dark yellowish brown (10YR 4/4); gi.
2.37–2.54	*Chara* ooze; mottled light brown (7.5YR 6/4) and pale brown (10YR 6/3), very friable, subangular blocky structure; rootlet casts 1.2 cm long in lower 3 cm; 2–5 mm wavy yellowish brown (10YR 5/4) band at 2.48m; vesicular carbonate nodules to 1 cm; dw.
2.54–2.60	*Chara* ooze; .5–1.5 cm black (10YR 2/1), brown (10YR 4/3) and yellowish brown (10YR 5/4) bands; gw.
2.60–2.66	*Chara* ooze; pink (5YR 7/3); no silt size calcareous fragments; very gelatinous; cw.
2.66–2.68	*Chara* ooze; yellowish brown (10YR 5/4); *Chara* oogonia abundant; cw.
2.68–2.71	*Chara* ooze; light brown (7.5YR 6/4) with 1 cm pink (5YR 7/3) lens at 2.69 m; gs.
2.71–2.76	*Chara* ooze; pale brown (10YR 6/3) with 1 cm brown (10YR 4/3) lens at 2.73 m; *Chara* oogonia abundant; gs.
2.76–2.81	*Chara* ooze; light brown (7.5YR 6/4); dw.
2.81–2.87	*Chara* ooze; pale brown (10YR 6/3); dw.
2.87–2.89	*Chara* ooze; light brown (7.5YR 6/4); gw.
2.89–2.94	*Chara* ooze; brown (7.5YR 5/4); slightly sticky, nonplastic; *Chara* fragments to 3.5 mm common; *Chara* oogonia abundant.
2.94–2.99	Core not recovered.

TABLE 14 (continued)

Description of Core II, Little Lake, California

Depth (meters)	Description
2.99–3.08	*Chara* ooze; light olive gray (5Y 6/2) grading upward to light brown (7.5YR 6/4); *Chara* oogonia abundant; cw.
3.08–3.19	*Chara* ooze; light reddish brown (5YR 6/4); ci.
3.19–3.24	*Chara* ooze; brown (10YR 4/3); 2–5 mm light brown (7.5YR 6/4) bands at 3.22 and 3.23 m; cw.
3.24–3.27	*Chara* oozé; very dark grayish brown (10YR 3/2); *Chara* fragments to 5 mm abundant; snails present; as.
3.27–3.49	*Chara* ooze; dark brown (10YR 3/3); *Chara* fragments to 5 mm abundant; *Ruppia* seeds abundant and snails present; gs. ^{14}C date at 3.39–3.49 m
3.49–3.74	*Chara* ooze; olive gray (5Y 4/2) grading upward to (5Y 5/2); *Chara* fragments to 5 mm abundant; *Ruppia* seeds abundant and snails present; di.
3.74–3.79	Micaceous clay; mottled olive gray (5Y 4/2) and dark greenish gray (5GY 4/1); very sticky; no silt size calcareous fragments; gw.
3.79–3.85	*Chara* ooze; olive gray (5Y 5/2); gi.
3.85–3.96	*Chara* ooze; olive gray (5Y 5/2) grading upward to light olive gray (5Y 6/2); *Chara* fragments to 2 mm; gi.
3.96–4.06	Clay; pale olive (5Y 6/3) with mottles of dark greenish gray (5GY 4/1) at top; gw.
4.06–4.17	*Chara* ooze; light reddish brown (5YR 6/4) grading upward to (5YR 6/3); *Ruppia* seeds and snails present; gs.
4.17–4.30	*Chara* ooze; yellowish brown (10YR 5/4); 1 cm brown (10YR 4/3) bands at 4.26 and 4.29 m; dw.
4.30–4.37	*Chara* ooze; pale brown (10YR 6/3) grading upward to very pale brown (10YR 7/3); snails present; gs.
4.37–4.51	*Chara* ooze; reddish brown (5YR 5/4) with pinkish white (5YR 8/2); *Chara* fragments very abundant at 4.44 cm; silt size calcareous fragments abundant; snails present; gs.
4.51–4.58	*Chara* ooze; yellowish brown (10YR 5/4); *Ruppia* seeds and snails present; gs.
4.58–4.63	*Chara* ooze; grayish brown (10YR 5/2); *Chara* fragments to 7 mm; gs.
4.63–4.65	*Chara* ooze; yellowish brown (10YR 5/4) with dark greenish gray (5GY 4/1) clay lenses; *Chara* fragments to 5 mm; cs.
4.65–4.68	*Chara* ooze; very pale brown (10YR 7/3); *Chara* fragments to 5 mm abundant; gs.
4.68–4.88	*Chara* ooze; pink (5YR 7/3); *Chara* fragments to 5 mm abundant; ds.
4.88–5.02	*Chara* ooze; pale brown (10YR 6/3); silt size calcareous fragments abundant; dispersed, vesicular carbonate nodules to 2 mm; snails present; gs. ^{14}C date at 4.91–5.02 m
5.02–5.11	*Chara* ooze; dark grayish brown (10Y 4/2) with mottles of pale brown (10YR 6/3); *Chara* fragments to 7 mm abundant.
5.11–5.21	Core not recovered.
5.21–5.24	*Chara* ooze; brown (10YR 5/3); 1 cm light brown (7.5YR 6/4) band at 5.22 m; *Chara* fragments to 5 mm; gw.
5.24–5.36	*Chara* ooze; light reddish brown (5YR 6/4) grading upward to brown (10YR 5/3); gw.
5.36–5.39	*Chara* ooze; brown (10YR 5/3) grading upward to (10YR 4/3); *Ruppia* seeds present; gs.
5.39–5.45	*Chara* ooze; olive gray (5Y 4/2); 1.5 cm dark grayish brown (10YR 4/2) band at 5.42 m; *Chara* fragments to 5 mm abundant; *Ruppia* seeds present; gs.
5.45–5.51	*Chara* ooze; light olive gray (5Y 6/2); *Ruppia* seeds present; gs.
5.51–5.56	Clay; greenish gray (5GY 5/1) with mottles of pinkish gray (7.5YR 7/2) at base; gi.
5.56–5.64	Clay; olive gray (5Y 4/2) grading upward to olive (5Y 5/4); silt size calcareous fragments abundant; vesicular carbonate nodules to 7 mm; gs.
5.64–5.70	Clay; mottled olive gray (5Y 4/2), olive (5Y 5/4) and black (5YR 2/1); *Typha* roots present; gw.
5.70–5.86	Peat; black (5Y 2/1) grading upward to very dark gray (5Y 3/1); *Typha* roots and snails common; gs.
5.86–5.89	Peat; brown (10YR 4/3); *Typha* roots and snails present; gs.
5.89–6.20	Peat; black (N 2/0); noncalcareous; *Typha* roots and snails present; gs. ^{14}C date at 5.91–6.01 m
6.20–6.38	Peat; 1–3 cm black (5Y 2/1 to N 2/0) and pinkish gray (7.5YR 7/2) bands; *Typha* roots present; ds.
6.38–6.53	Peat; black (N 2/0); *Typha* roots, snails and bone present; gs.
6.53–6.67	Peat; mottled black (5Y 2/0), olive gray (5Y 4/2) and brown (10YR 5/3); *Typha* roots and snails present; gw.
6.67–6.76	Micaceous clay and sand; dark greenish gray (5GY 4/1); *Typha* roots and snails present; gw.
6.76–6.97	Peat and clay; mottled dark greenish gray (5GY 4/1), light gray (7.5YR 7/2) and olive gray (5Y 4/2); *Typha* roots and snails present; ds.
6.97–7.03	Peat; black (5Y 2/1); *Typha* roots and snails present.
7.03–7.24	Core not recovered.
7.24–7.29	Peat; black (5Y 2/1); *Typha* roots present; gw.
7.29–7.43	Clay; dark greenish gray (5GY 4/1); *Typha* roots and snails present; gw.
7.43–7.49	Clayey silt; mottled black (5Y 2/1) and pinkish gray (7.5YR 7/2); *Typha* roots present; cw.

TABLE 14 (continued)

Description of Core II, Little Lake, California

Depth (meters)	Description
7.49–7.56	Clayey silt; pinkish gray (7.5YR 7/2) grading upward to brown (10YR 4/3); gw.
7.56–7.63	Clayey silt; mottled black (10YR 2/1) and (5Y 2/1); *Typha* roots and snails present; gw.
7.63–7.71	Peat; black (10YR 2/1); noncalcareous; snails present; gs.
7.71–8.13	Peat; black (N 2/0); noncalcareous; snails common; gs. ^{14}C date at 7.86–7.96 m
8.13–8.19	Peat; black (10YR 2/1); noncalcareous; snails common; cw.
8.19–8.31	Micaceous clay and sand; olive gray (5Y 5/2); 3 cm black (10YR 2/1) band at 8.25 m; dw.
8.31–8.60	Clayey silt; mottled light olive gray (5Y 6/2), brown (10YR 5/3), yellowish brown (10YR 5/4) and pale brown (10YR 6/3); silt size calcareous fragments abundant; snails and bone present; ds. ^{14}C date at 8.31–8.41 m
8.60–8.71	Clayey silt; brown (10YR 4/3); 1 cm dark grayish brown (10YR 4/2) band at 8.67 m; silt size calcareous fragments abundant; ci.
8.71–8.74	Peat; black (10YR 2/1); noncalcareous; gi.
8.74–8.86	*Chara* ooze; pale brown (10YR 6/3) grading upward to very dark grayish brown (10YR 3/2); cw.
8.86–8.89	*Chara* ooze; olive gray (5Y 5/2); gw.
8.89–9.06	*Chara* ooze; mottled brown (10YR 5/3), yellowish brown (10YR 5/4) and pale brown (10YR 6/3); *Chara* fragments to 5 mm abundant; snails present; gs.
9.06–9.11	*Chara* ooze; brown (10YR 4/3); *Chara* fragments to 5 mm abundant; snails present; gs.
9.11–9.19	*Chara* ooze; olive gray (5Y 5/2); *Chara* fragments to 5 mm abundant; aw.
9.19–9.31	Micaceous sand; dark greenish gray (5GY 4/1); as.
9.31–9.50	*Chara* ooze; brown (10YR 4/3); *Chara* fragments to 5 mm abundant; snails common; cw.
9.50–9.56	Silty peat; mottled black (10YR 2/1) and dark gray (10YR 4/1); snails abundant.
9.56–9.66	Core not recovered.
9.66–9.98	*Chara* ooze; dark brown (10YR 3/3) to brown (10YR 5/3); 3–4 mm black (10YR 2/1) peat lenses at 9.77 and 9.90 m, 3–5 mm dark greenish gray (5GY 4/1) clay lenses at 9.70, 9.76, 9.81, 9.86, 9.88 and 9.96 m; snails present; as.
9.98–10.01	Peat; very dark gray (10YR 3/1); *Typha* roots and snails present; dw.
10.01–10.11	Clay; dark greenish gray (5GY 4/1); no silt size calcareous fragments; *Typha* roots present; gw.
10.11–10.20	Clay; brown (10YR 5/3) grading upward to olive gray (5Y 4/2); gw.
10.20–10.33	*Chara* ooze; olive gray (5Y 4/2) grading upward to brown (10YR 4/3); *Chara* fragments to 2 mm abundant; gw.
10.33–10.47	*Chara* ooze; brown (10YR 4/3); 5 mm dark greenish gray (5GY 4/1) bands at 10.40 and 10.46 m and 5 mm olive gray (5Y 5/2) clay band at 10.36 m; gs.
10.47–10.55	*Chara* ooze; dark brown (10YR 3/3); 2–5 mm black (10YR 2/1) band at 10.53 mm; *Chara* fragments to 2 mm abundant; snails present; gw.
10.55–10.59	Clayey silt; olive gray (5Y 4/2); silt size calcareous fragments abundant; gs.
10.59–10.65	*Chara ooze;* mottled brown (10YR 4/3) and (10YR 5/3); *Chara* fragments to 2 mm abundant; gs.
10.65–10.73	*Chara* ooze; brown (10YR 5/3) with mottles of pale brown (10YR 6/3); silt size calcareous fragments abundant; vesicular carbonate nodules to 5 mm; cs.
10.73–11.07	*Chara* ooze; brown (10YR 5/3); snails present; ci.
11.07–11.16	Peat; black (10YR 2/1); snails common; gi.
11.16–11.19	Clay; dark greenish gray (5GY 4/1); snails common; gs.
11.19–11.28	Peat; black (10YR 2/1); no silt size calcareous fragments; snails common. ^{14}C date at 11.21–11.28 m

pated. Therefore, it was necessary to evaluate the potential of dating the various fractions of the different sediment types, and some modern plants contributing to the sediments. Organic residue, carbonate and humate fractions, and modern *Chara* sp. and *Potamogeton pectinatus* were investigated (Table 15). Only the peats provided apparently reliable age determinations.

The radiocarbon samples were treated routinely (Ralph 1971; Olsson 1972). Dilute hydrochloric acid removed carbonates; after several water washes humic acids were removed with two treatments of hot, dilute sodium hydroxide. Another water wash was used to remove the residual humic acid. The humic acid-free residue was treated again with dilute hydrochloric acid and then with water until the washes were neutral. The residues and humic acid fractions of each sample were dried, converted to CO_2, reduced to CH_4 and counted.

There are two distinct classes of radiocarbon dates reported in Table 15: (1) peat dates; (2) anomolously "old" dates derived from *Chara* ooze and modern *Chara* and *Potamogeton*. The *Chara* ooze dates suggest that "old" carbon was mixed with "modern" carbon when the submerged aquatic plants (*Chara* and *Potamogeton*) were metabolizing this mixture in the

TABLE 15

Little Lake radiocarbon dates.

Depth (meters)	WSU No.	Material Dated	Apparent Radiocarbon Age, Years BP	f_m (b)
	1460	Modern *Chara*	3660 ± 120 (a)	0.48 (c)
	1473	Modern *Potamogeton*	3020 ± 80	0.69 (c)
1.17– 1.25	1461	*Chara* ooze	7160 ± 100	0.45
	1490	Carbonate	7060 ± 100	
3.39– 3.49	1462	*Chara* ooze	6030 ± 150	0.58
	1462H	Humic acid	6030 ± 100	
4.91– 5.02	1465	*Chara* ooze	6380 ± 150	0.60
5.91– 6.01	1474	Peat	3020 ± 120	1.00
7.86– 8.96	1466	Peat	3980 ± 120	1.00
8.31– 8.41	1463	*Chara* ooze	9480 ± 200	0.50
11.21–11.28	1464	Peat	5050 ± 140	1.00
	1464H	Humic acid	5000 ± 140	

(a) Radiocarbon ages are based on the 5568-year ^{14}C half-life and are relative to NBS oxalic acid. Errors are one sigma values derived from counting data. No corrections have been made for isotopic fractionation of ^{14}C, which is estimated to be less than 200 years (Sheppard 1975).

(b) f_m = Initial fraction of modern carbon in living aquatic plants

$$= \frac{R_{obs} - R_o}{R_m - R_o}$$

where R_{obs} = the observed ^{14}C counting rate for a given sediment depth; R_m = the extrapolated ^{14}C counting rate for a given sediment depth; R_o = the ^{14}C counting rate of "old" or "ancient" carbon, assumed to be zero. The average of non-peat f_m's is 0.55 ± 0.09.

(c) Corrected for hydrogen-bomb-produced ^{14}C using the data of Lowdon and Dyck (1974).

form of bicarbonate ion (Deevey, Gross and Hutchinson 1954). It is likely that the chemical reaction, $Ca^{12}CO_3 + {}^{14}CO_2 + H_2O = Ca^{2+} + H^{12}CO_3^- + H^{14}CO_3^-$, was (and is) taking place in the spring waters that feed Little Lake. The effect of this reaction is to make the radiocarbon ages of all fractions of *Chara* ooze about 5500 years older than they really are. Peats were derived primarily from *Scirpus* and *Typha*. Since these plants obtain their carbon from the atmosphere, radiocarbon dates of peat are better measures of true age.

To test the above hypothesis, a plot of the peat ^{14}C counting rates was made. The plot shown in Fig. 90 extrapolates to the modern or NBS reference value for the WSU ^{14}C counting tube. The R_m's used to calculate the f_m values reported in Table 15 were obtained from Fig. 90. The average f_m value for the *Chara* ooze (0.55 ±0.09) supports the hypothesis that the bicarbonate reaction takes place in the spring waters feeding Little Lake.

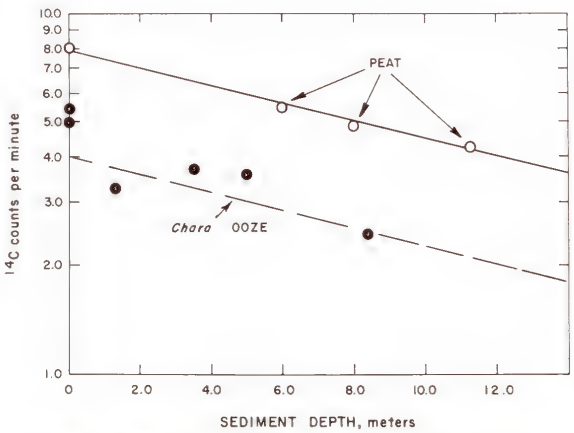


FIGURE 90. A plot of the ^{14}C counts per minute for the radiocarbon samples given in Table 15. Open circles represent peats and the modern oxalic acid standard. Closed circles represent *Chara* ooze, and modern *Chara* and *Potamogeton*; the latter (plotted at zero depth) are not corrected for hydrogen-bomb-produced ^{14}C. Dates on the various fractions of *Chara* ooze average about one ^{14}C half-life older than those derived from peats of similar depth.

INTERPRETATION

We interpret past sedimentary regimes, aquatic vegetation, and corresponding water availability by comparisons with modern analogues occurring at Little Lake. There are three easily distinguishable sedimentary environments associated with the lake and springs; each has distinctive sediments and vegetation. In order of decreasing water availability they are: (1) shallow, hard water lake with a *Chara* mat; (2) sedge and cattail marsh; (3) salt grass meadow (Fig. 87). The distinguishing sediments (*Chara* ooze, peats, and mottled clayey silt and sand) and some common modern plants presently being deposited in the three depositional en-

TABLE 16

Interpretation of past depositional environments from the sediments and fossil pollen and seeds of the Little Lake cores.

Sediments	Fossils	Environments
Chara Ooze	*Chara*	Shallow Lake
	Potamogeton	
	Ruppia	
Peats	*Scirpus*	Marsh
	Typha	
	Ruppia	
Mottled	*Distichlis*	Salt Grass
Clay, Silt	*Nitrophila*	Meadow
and Sand	*Anemopsis*	

vironments are given in Table 16. Interpretation of habitat history, based on the sediments and fossils, is summarized in Fig. 91.

Roots and *Ruppia* seeds were easily recognizable while logging the core. The upper limit of *Typha* and/or *Scirpus* roots represent two definite surfaces of marsh growth at 5.64 and 9.98 m. In each case overlying *Chara* ooze probably represents increased water depth and drowning of the marsh. The depths of these surfaces are especially significant in precisely establishing past water levels within the Little Lake Basin at 7.64 and 11.98 m below the high water level of the past few years. *Ruppia* seeds which are today most abundant in shallow lake and deeper marsh habitats were common in the *Chara* ooze, but not observed in the peats and mottled inorganic sediments below 5.51 m. We believe distribution of these two conspicuous plant macrofossils is indicative of generally low water availability below 5.51 m and deeper water thereafter.

Preliminary pollen analysis of the core showed considerable variability in the pollen of terrestrial, aquatic and marsh species. The common occurrence of four of these with depth is shown in Fig. 91. *Typha* pollen accounts for more than 5% of total aquatic pollen in only two areas of the core. In both it occurs in peats and mottled inorganic sediments, and partly in association with the *Typha* roots. Based on its present distribution, *Typha* remains are in agreement with the sediment evidence for shallow marsh deposition.

Scirpus pollen is common throughout the core except at places within the *Chara* ooze above 4 m. Since *Scirpus* produces abundant wind transported pollen, its presence indicates marsh habitat within the Little Lake Basin. On the other hand, generally low values of *Scirpus* pollen in the *Chara* ooze above 3.5 m may represent deep water with the subsequent loss of marsh habitat adjacent to the basalt cliffs and restriction of *Scirpus* to areas further from the coring site.

More than 2% *Potamogeton* pollen occurs only in the *Chara* ooze above 4 m and is further evidence for open water deposition. *Ruppia* is the dominant aquatic

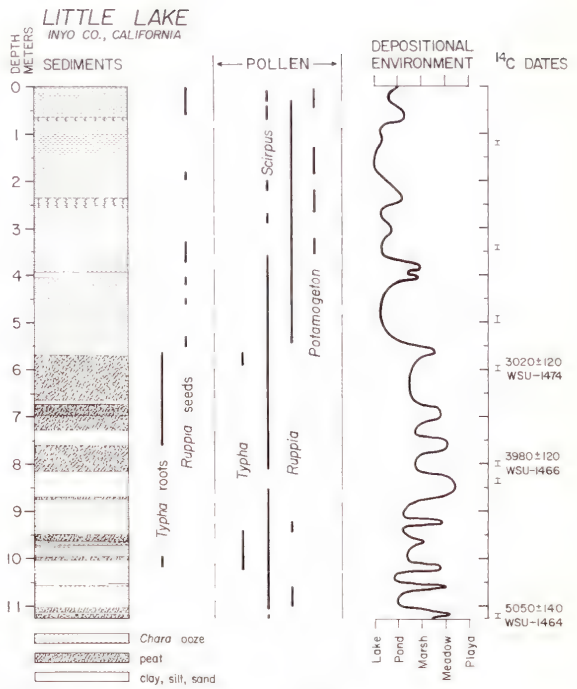


FIGURE 91. Summary diagram of Little Lake history interpreted from the sedimentary and fossil records (see Table 16). The depths of all radiocarbon dates are plotted but only the peat dates are given. Radiocarbon dates are listed in Table 15.

pollen throughout most of the *Chara* ooze, otherwise it is less abundant than *Typha* and/or *Scirpus* pollen.

A possible modern analogue for the subangular blocky structure, indicated in Fig. 91 at 2.37 m, and by correlation with Core I at 0.66 m, occurs on the seasonally dry lake margin. As the water level recedes during the summer and fall, polygonal cracks develop in the desiccating lake-edge sediments (Figs. 86 and 88). They harden and a vesicular carbonate crust with *Chara* flotsam inclusions forms on the surface. Thus, the sediment structure may represent the shore of a fluctuating pond with water deep enough during the winter to inhibit marsh succession onto the seasonally exposed surface.

By combining the preliminary aquatic pollen data, distribution of *Typha* roots and *Ruppia* seeds and the sediment type, we have attempted to reconstruct lake history to the extent of identifying the depositional environment at the coring site. It seems quite probable that the Little Lake Basin was never a completely dry, wind scoured, barren playa during the time represented by our record. However, for a considerable part of the Holocene the lake has been smaller than present or absent, and the basin has been primarily occupied by shallow ponds, marshes and salt grass meadows.

While the water surface about 5,000 BP was at least 13 m below the high level of the past few years, the lake seems never to have been much deeper or fresher than now. We would expect prolonged periods of deeper

water or through flowing drainage from the Sierra Nevada to be reflected in the sediments or their fossils. However, the calcareous environment persists above 5.89 m; there are no finely laminated silts and clays or lake deposits lacking fossil *Chara,* as might be expected with considerable, long-term freshening of the lake. All lake sediments and their fossils are characteristic of deposition in shallow, hard and warm water.

Fossil snails are in agreement with other data indicating shallow lake and bordering marsh habitats. While snails were common in the cores (Table 14) only *Physa virgata* was abundant. *Gyraulus parvus* (7.77 m) and *Planorbella tenuis* (10.45 m) were represented by single specimens from Core II and the latter by a single specimen (10.14 m) from Core I.

Discussion

Interpretation of lake history in terms of the chronology of depositional environments and further extrapolation to past water availability is the first step in understanding the local and regional nature of changes in Little Lake aquatic habitats. Therefore, we have attempted to provide a relative estimate of past water availability (Fig. 91). However, the ultimate cause(s) of the changes in depositional environment are more difficult to evaluate. Fig. 92 illustrates a simple case for a spring-fed lake in which climatic change would account for variations in water availability which, acting through water depth and chemistry, would control deposition.

Although we believe it is possible to establish past water availability and habitat history, and that climatic change is probably reflected in past Little Lake depositional environments, the regional climatic significance remains uncertain. At Little Lake, water availability has probably been influenced by tectonic activity, through its effect on ground water flow and discharge, by the rates of alluvial contribution to the dam, and by erosion at the outlet. These factors may have been totally or partially independent of regional climatic trends. For example, erosion or deposition could have been influenced by tectonically induced local base level changes as well as by climatic change. Thus, adequate evaluation is not possible without considerably more information on the hydrology and structural geology of the Little Lake area.

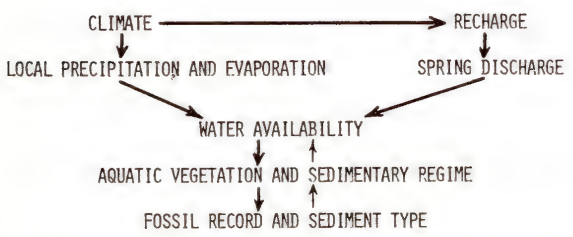


Figure 92. A generalized model of the relationship of lake history to regional and local causes. Past water availability is suggested directly by the sedimentary and fossil records. However, interpretation of the ultimate causes for changes in depositional environments requires the more difficult evaluation: of the effects of recharge and discharge, and local changes in, for example, evaporation. At Little Lake, local tectonic activity could have influenced spring discharge, local base level and alluvial contribution to the dam.

Minor fluctuations of closed-basin lakes over the last 7,000 years reflect the climatically controlled balance between inflow and evaporation (Hardman and Venstrom 1941; Peck and Richardson 1966; Snyder and Langbein 1962). Therefore, a comparison of the Little Lake water availability chronology with similar information from other Great Basin hydrologic basins could provide some clues to ultimate causes. If similar sequences of water availability occurred elsewhere the Little Lake fluctuations might more probably have resulted from regional events and climatic change would provide a likely explanation; exceptions would be indicative of a local cause(s). The question is then, is the chronology of Little Lake water availability similar to other Great Basin aquatic habitat histories?

Evidence for recent lake histories comes from Carson Sink and Pyramid Lake, Nevada. The level of Pyramid Lake is controlled primarily by discharge of the Truckee River originating at Lake Tahoe in the Sierra Nevada. From 1840 to 1970 Pyramid Lake fluctuated about 100 feet (30 m) (Born 1970, Fig. 36). However, prior to the 1905 diversion of the Truckee River, Pyramid Lake fluctuated only 20 feet (6 m) between high water stands of about 3,860 and 3,880 feet (1176 and 1182 m). During the drought of the mid-1960's archaeological sites at elevations below any prior historic stands were excavated by Donald R. Tuohy; one of these at 3,788 feet (1155 m) contained *Artemisia* wood radiocarbon dated at 2480 ±120 BP (Gak-2386).

Radiocarbon dating and stratigraphy of the Truckee River Delta at Pyramid Lake are interpreted as indicating two lake cycles in the past 4,000 years (Born 1970, Fig. 29). The lake is thought to have been low from 8,000 to 3,500 BP and again between about 2,000 and 1,000 BP. The high stand of the most recent lake cycle dates from the past few hundred years.

Five lake cycles, spanning the past 4,000 years, are described from Carson Sink (Morrison and Frye 1965: 19). They represent lake rises, with intervening desiccations, or near desiccations following a long dry period (Morrison 1964:75). The most severe period of desiccation is thought to have occurred about 600 BP between the second and third lake cycles and the last major lake maximum occurred within the past 100 years (Morrison 1965:281). Lack of sufficient radiocarbon

control and apparent differences in the ages and number of lake cycles recognized for Pyramid Lake and Carson Sink preclude correlation.

Pollen analysis of a core from Great Salt Lake, Utah, reveals a history of lake oscillations with higher-than-present levels about 6,000, 3,600 and 2,800 BP (Mehringer, unpubl.). Probable flooding of the Great Salt Desert, between 3500 and 2200 BP, is recorded in the subsurface stratigraphy, and in fossil pollen and diatoms of a playa-edge spring-fed salt marsh west of the Terrace Range, Utah (Crescent Spring, Mundorff 1971:37). Morrison (1965:281) suggests several rises of Great Salt Lake within the past 4,000 years with the maximum at 4,260 feet (1298 m) and equivalent to the Gilbert level (Eardley 1962:18; Eardley, Gvosdetsky and Marsell 1957, pls. 1,2,3).

The archaeological chronology of the Great Salt Lake area furnishes additional evidence for former lake levels. Several sites along the Bear River and northeast arm of Great Salt Lake (Aikens 1967) lie at an elevation of about 4210 (1283 m) feet, a foot (0.3 m) below the highest historic stand of 1873 (Peck and Richardson 1966, Fig. 4). The sites were flooded within historic time and must have been above the lake when occupied about 1,000 BP. Occupation of Stansbury Island is thought to require a land connection with the mainland to the south. A 7,000 BP date from Sandwich Shelter (Marwitt, Fry and Adovasio 1971) is interpreted as a minimum age for a water level lower than the connecting bar at 4,206 feet (1282 m).

In the Southern Great Basin of California recent lakes have been described from Searles and Death valleys. The Searles Lake Overburden Mud represents at least one lake stand following a period of desiccation represented by the Upper Salt (Smith 1968). The radiocarbon dates, on a variety of materials, do not permit fine chronological discrimination; however, one wood date of about 3,500 BP serves as a maximum age for the stratigraphic middle of this depositional episode. In Death Valley a recent shallow lake is recorded by shore lines and salt deposition (Hunt *et al.* 1966:48; Hunt and Mabey 1966:82). A minimum age of about 2,000 years is based on overlying dunes lacking artifacts older than those characteristic of Death Valley III occupation (Hunt 1960:111). Cores from Warm Sulphur Spring, Panamint Valley (Mehringer, unpubl.), reveal a period of increased spring discharge and subsequent marsh expansion radiocarbon dated at 3,500 BP (A-952).

From the preceding brief summary of lake fluctuations it is apparent that significant Holocene changes in aquatic habitats have occurred throughout the Great Basin. Specifically, there seems to be agreement that lakes became deeper sometime between 4,000 and 3,000 BP. The major change from marsh to lake deposition at Little Lake also occurs about 3,000 BP. Regional climatic variation might have influenced Little Lake through some combination of decreased evaporation, increased precipitation, recharge and spring discharge, and/or increased erosion or deposition of alluvium at the outlet. While we do not yet have enough information to identify the most important controlling factor(s) or to exclude non-climatic controls, the gross chronological correspondence over such a large area is intriguing. There seems sufficient reason to suggest that the fluctuating water availability of Little Lake over the past 5,000 years is at least partly a reflection of regional climatic change, but the present existence of a lake during a time characterized elsewhere by relative aridity is in conflict with the generalization. Also, during periods of exceptional moisture, down-cutting of the Little Lake dam could lead to lowering of the local water table.

Little Lake aquatic environments have been partly controlled by the deposition of alluvium contributing to the dam and accumulation rates would most probably vary with annual precipitation or rainfall intensity. The only data available with which to judge conceivable deposition rates come from the toe of a small fan about 400 m northwest of the Little Lake Hotel (Figs. 83 and 85). Headward erosion initiated at a small gravel pit exposed sediments containing aboriginal hearths. One of these, 1.5 m below the surface, was dated at 1420 ±70 BP (Tx-1195). Thus, sediments have been contributed to the outlet area of Little Lake into recent times.

Summary and Conclusions

In conjunction with archaeological studies at China Lake, cores were obtained from Little Lake, Inyo Co., California. By studying the cores we hoped to establish the age of the last overflow of Pluvial Lake Owens, and to obtain information about subsequent environmental history and resource availability for the aboriginal occupants of the northwestern Mohave Desert.

While the primary goals were not fully realized, study of over 11 m of sediments spanning the last 5,000 radiocarbon years did provide a history of water availability for Little Lake. We reconstruct the history as follows:

1. From about 5,000 to 3,000 BP the Little Lake Basin was occupied by salt grass meadow, marsh and ponds. The local water table was as much as 13 m below the high water levels of the past few years.

2. After 3,000 BP, the sediments and fossils are interpreted as indicating a shallow lake.

3. Within the lake sediments, brief but significant lowering of the water table is suggested by a return to marsh deposition near 4 m depth. Sediment structure at 2.37 and 0.66 m indicates seasonally dry lake-edge at the coring sites.

4. While Little Lake has been shallower than present there is no clear evidence that it has been much deeper or fresher during the past 5,000 years.

Changing water availability at Little Lake may be a direct reflection of climatic change and provide a chronology of relative effective moisture for the northwestern Mohave Desert. However, local factors, particularly faulting, might also have been responsible for some variation in water availability. Determination of the ultimate cause(s) for the changing water table requires a better understanding of the structural geology and rates of deposition from alluvial fans below Little Lake.

With the exception of three peat ages, radiocarbon dates were derived from submerged aquatic plants that utilized ''old'' bicarbonates and gave apparent ages that are several thousand years too old. Further study of lake and spring water chemistry would contribute to a more refined chronology.

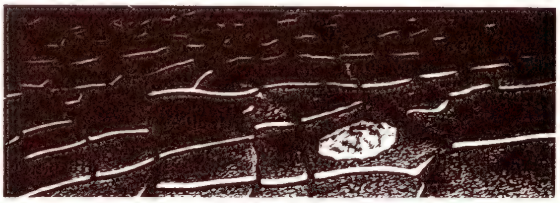
Acknowledgments

This research is a continuation of studies of the history of desert aquatic habitats initiated through NSF Grant GB-8646 and was partially supported by NFS Grant GS-3700-2 to the Los Angeles County Museum. The project was initiated at the request of Emma Lou Davis, who organized logistic and financial support. Lisa G. Bostwick and Don G. Wyckoff participated in all field work and laboratory analyses. Dwight W. Taylor identified the fossil molluscs and George I. Smith provided helpful suggestions throughout the study.

Chapter 7
LAKE WISCONSIN-SUBRECENT SOILS AT CHINA LAKE

By George I. Smith[8] and Emma Lou Davis

The Soils



A number of ^{14}C dates have been obtained from China Lake soils. Most of these assays are unsatisfactory due to carbonate contamination, confused stratigraphies, or both. A more precise estimate of the age of the artifacts and the sediments containing them can probably be made by correlation of these deposits with deposits in Searles Lake to the east where better ^{14}C dating is available. China and Searles Lakes lie in basins that contained lakes at the same times, and the sequences of lacustrine deposits in both areas must be related. The sequence of fossil soils, along with the sequence of lacustrine and alluvial sediments, provide the main basis for correlation. Experience and observations in Searles Valley and other areas suggest that soils tend to have formed at the same times in widely spaced areas during the Late Pleistocence, and this assumption is made in this area as well (Fig. 93).

The best locality in China Lake studied to date is at Stake 1, Trench 3 (Fig. 94). The sequence of sediments is as follows: an overlying unit composed of unindurated, medium-grained, yellowish-red sand, apparently of lacustrine origin and with a weak soil near the middle of the unit, rests on a more indurated lacustrine that has a pronounced fossil soil near the top. The fossil soil consists of calcium carbonate pods, one-half to one-quarter inch in size, that occupy a zone several inches below the contact between the overlying and underlying units. These China Lake soils are similar to those in Searles Valley (informally designated as soils BC and CD). It is not compellingly similar to either, but its position in the inferred sequence of depositional events makes it likely to be correlative with the soil CD. The sediments on which the soil is formed are lacustrine sands, medium to poorly sorted, and largely free of silt- and clay-sized material except near the soil horizon where pedogenic clay is intermixed. Sedimentary analyses of the sediments in the upper and lower units are compatible with a lacustrine origin for them (Tables 17 and 18). The color and lithology suggest that the upper unit was formed in a shallow wind-stirred lake that prevented reducing conditions on the bottom and would account for the yellowish color and the lack of green clays and silts in this section. The sedimentary details of the underlying unit suggest that it was formed in a deeper lake, and presumably was the result of deposition under conditions similar to those that formed greenish clays in Searles Valley. There, deep lakes, commonly stratified so that wind action did not affect bottom sediments, allowed reducing conditions to exist on the bottom and thus prevented complete oxidation of the contained material. Both types of oxidation are consistent with the lakes that deposited two separable units in Searles Valley, which are designated in field use as unit D (the younger) and unit C. Unit D is a Holocene lake, which has estimated age limits that range from about 2,000 to 6,000 years ago. Unit C in Searles Valley has age limits estimated to be between 12,000 and 10,500 years ago. The arid interval between deposition of these two in Searles Valley is represented by an alluvial layer and a weak soil. The soil-forming interval is estimated to have lasted from about 6,000 to nearly 10,500 years ago.

The correlation of China Lake units with Searles Valley ones, if correct, means that the artifact material resting on the surface and characterized by the "flaggy sandstone," and which underlies the yellowish capping sandstone in China Lake, is at least 6,000 years old (Fig. 95, Tables 17–18), and must be no older than 10,500 years and probably is younger. There is no reliable geological method to determine if the artifact materials were deposited after the soils were formed, or if some were deposited on the surface before and during the time the soils developed. The differences in relative weathering of artifacts and flakes probably are providing some of the answers.

Artifacts found in the capping sandstone are estimated to be at least 2,000 years old but not more than 6,000.

[8]U.S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025.

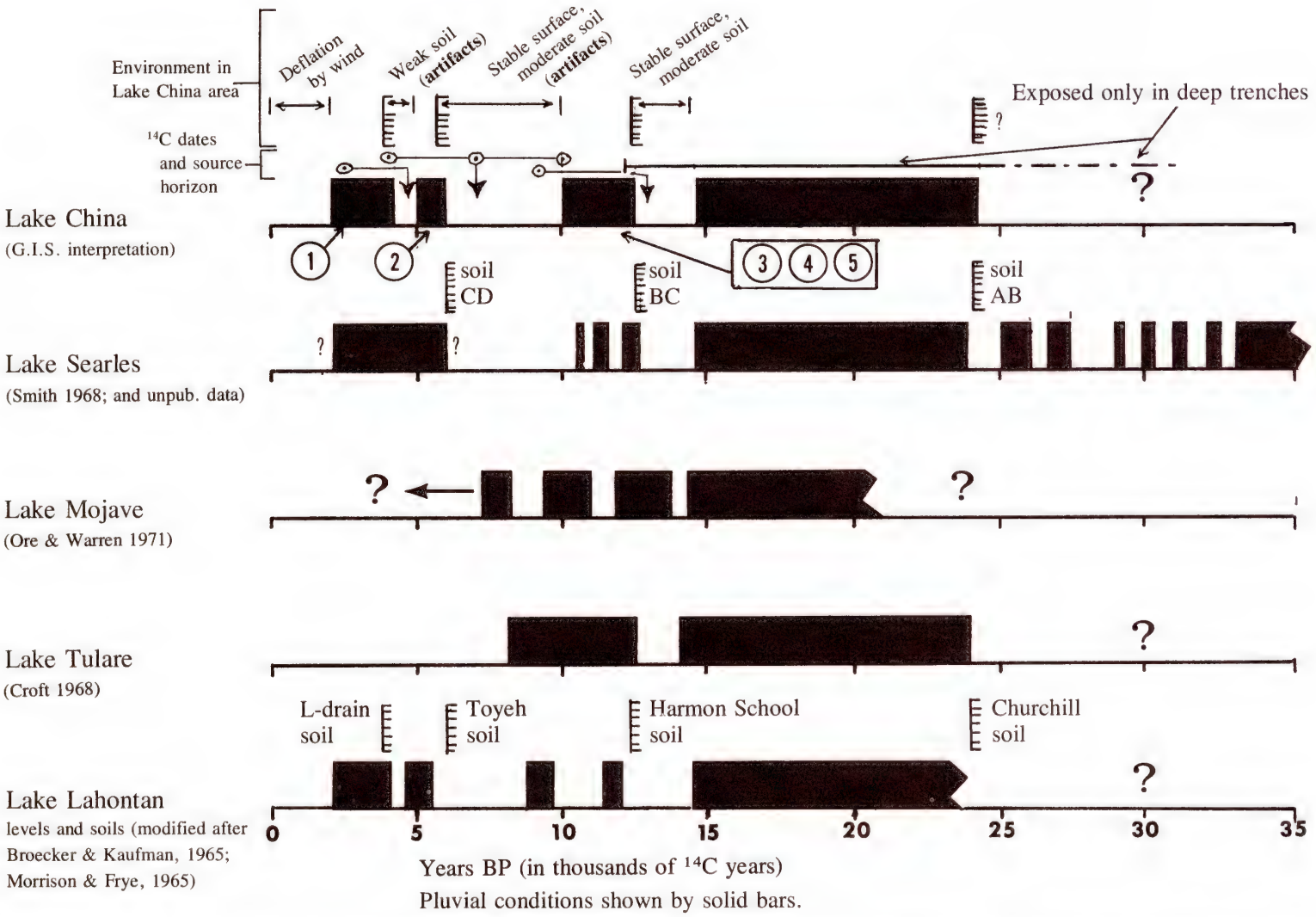
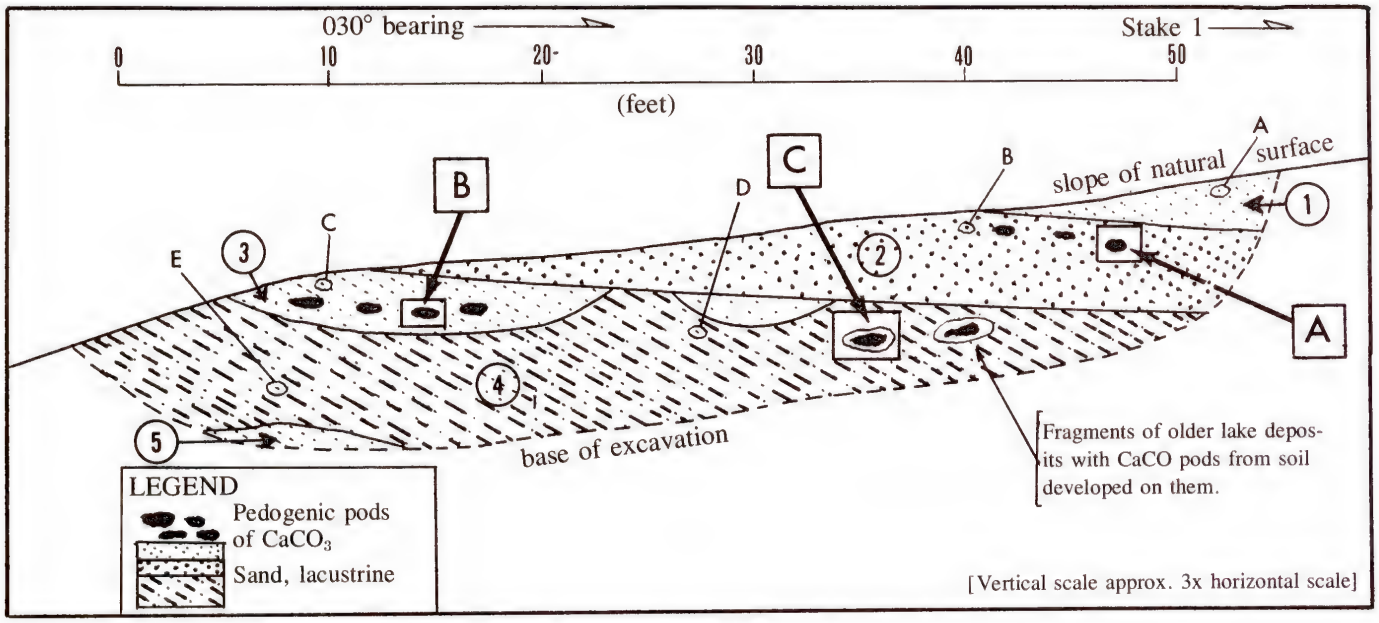


FIGURE 93. A geological comparison of 5 pluvial lakes in Western North America. This shows that major episodes of high water, low water, and soil formation were comparable over long distances.



China Lake, Calif.
Stake 1, trench 3
Field notes by G.I. Smith and E.L. Davis, 3-24-74 & 11-9-74

SUMMARY OF ^{14}C DATES

A Weak calcareous soil, color of zone 10 YR 6-7/2, dated material: $CaCO_3$. RESULT: 2,465 ± 180 (GX 3445) on conc. $CaCO_3$.

B Moderately strong calcareous soil, carbonate pods from "flaggy sandstone" fragments along line of outcrop, soil color 10 YR 5/4 imposed on top 8 in. of unit; dated material: $CaCO_3$ (equivalent to GX 3441).

RESULTS: 10,275 ± 165 (GX 3442) on hard $CaCO_3$ coll. 3-24-74
6,775 ± 260 (GX 3443) on soft $CaCO_3$ coll. 3-24-74
4,305 ± 135 (GX 3723) on soft $CaCO_3$ coll. 11-9-74

C Fragments containing calcareous soil, color of soil zone 10 YR 6/6 (in matrix of 5 Y 6/1), dated material: $CaCO_3$ formed after matrix deposited but before fragment broken and transported.

RESULT: 9,390 ± 365 (GX 3444) on hard $CaCO_3$.

FIGURE 94. Surface stratigraphy and associated radio-carbon dates in the Stake 1, Trench 3 profile.

China Lake-archaeological sites, stratigraphic section

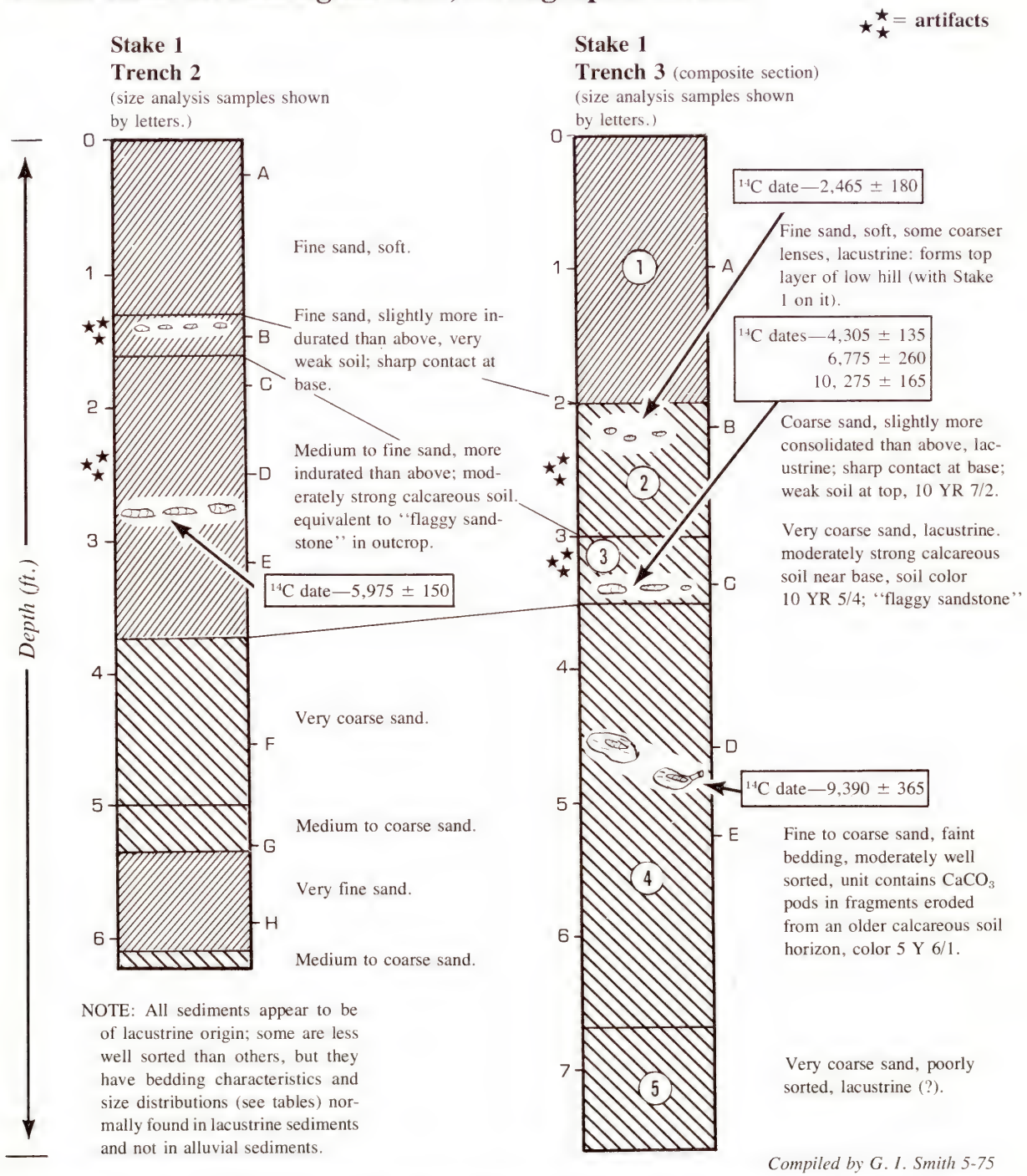

= artifacts
Stake 1
Trench 2
(size analysis samples shown by letters.)
Stake 1
Trench 3 (composite section)
(size analysis samples shown by letters.)
Depth (ft.)
0
1
2
3
4
5
6
7
A
B
C
D
E
F
G
H
Fine sand, soft.
Fine sand, slightly more indurated than above, very weak soil; sharp contact at base.
Medium to fine sand, more indurated than above; moderately strong calcareous soil, equivalent to "flaggy sandstone" in outcrop.
14C date—5,975 ± 150
Very coarse sand.
Medium to coarse sand.
Very fine sand.
Medium to coarse sand.
NOTE: All sediments appear to be of lacustrine origin; some are less well sorted than others, but they have bedding characteristics and size distributions (see tables) normally found in lacustrine sediments and not in alluvial sediments.
14C date—2,465 ± 180
Fine sand, soft, some coarser lenses, lacustrine: forms top layer of low hill (with Stake 1 on it).
14C dates—4,305 ± 135
6,775 ± 260
10, 275 ± 165
Coarse sand, slightly more consolidated than above, lacustrine; sharp contact at base; weak soil at top, 10 YR 7/2.
Very coarse sand, lacustrine. moderately strong calcareous soil near base, soil color 10 YR 5/4; "flaggy sandstone"
14C date—9,390 ± 365
Fine to coarse sand, faint bedding, moderately well sorted, unit contains CaCO3 pods in fragments eroded from an older calcareous soil horizon, color 5 Y 6/1.
Very coarse sand, poorly sorted, lacustrine (?).
Compiled by G. I. Smith 5-75

FIGURE 95. Stratigraphic sections of two trenches at Stake 1 showing associations of pedogenic nodules of "flaggy sandstone" with radio-carbon dates and artifacts.

TABLE 17

Size analyses of sediment samples collected at China Lake, California, Stake 1, trench 2.
Sampled March 24 and November 8, 1974 by G. I. Smith and E. L. Davis, size analyses by G. Harris

Size (mm)	Sample designation (Values as weight percent) A	B	C	D	E	F	G	H	Size Description
>4	0.0	0.2	0.2	1.4	8.2	14.4	2.0	0	Pebbles
2–4	0.3	4.7	5.7	17.9	6.4	40.1	7.6	0.9	Granules
1–2	8.0	19.4	23.2	24.3	23.8	25.3	28.5	5.1	Very coarse sand
0.5–1	25.2	20.0	16.0	13.8	15.6	9.0	30.3	8.5	Coarse sand
0.25–0.5	28.5	22.6	18.9	16.2	17.5	6.4	22.0	7.8	Medium sand
0.125–0.25	27.6	21.9	21.7	16.7	16.2	2.9	6.6	15.4	Fine sand
0.0625–0.125	8.1	8.7	9.6	17.9	9.0	1.2	2.1	34.5	Very fine sand
<0.0625	2.3	2.5	4.7	1.8	3.3	0.7	0.9	27.8	Silt and clay

Artifacts on the top surface are estimated to be as young as 2,000 years or older because since that unit was deposited losses have occurred through wind erosion.

Bone and artifacts in the material beneath the fossil soil are presumably more than 10,500 years old. The ^{14}C dates obtained on samples from the Stake 1 Trench 3 locality, reported in July 1974, indicate a date for the soil in the overlying lacustrine sand 2,465 ±180; this is consistent with the age estimated (but not well determined) in Searles Valley. The ^{14}C ages on two samples of the flaggy sandstone (fossil soil) were 10,275 ±165 and 6,775 ±260; our estimate is that the 6,775 age is more nearly correct than the 10,275 date, but this obviously reflects our prejudice. The age of carbonate found as fragments in the underlying lacustrine material, which was eroded from an older and previously formed fossil soil horizon, was 9,390 ±365; a more likely age would be 12,000 to 14,000 years or older, but again this is not a provable assignment. The one date in the Stake 1 Trench 2 unit, which indicated a ^{14}C age of 5,975 ±150, is reasonably compatible with the 6,775 age on what appears to be the same horizon in Stake 1 Trench 3.

There are three possible alternative interpretations of the soils and sediments exposed in Stake 1, Trench 3. 1) Material above the flaggy sandstone is correlative with Unit C in Searles Lake and therefore has an age between 10,500 and 12,000 years. 2) The soil is correlative with Unit BC in Searles Lake and therefore has an estimated age of 12,000 to 14,000 years, and 3) that the underlying material is correlative with Unit B in Searles Lake and therefore has an age of 14,000 years or older. Several lines of geologic evidence, however, make this alternative choice a less likely one.

The genealogy of the gravel cover at Stake 1 is still a difficult decision. It looked more lacustrine than alluvial, but the size of the fragments makes this origin somewhat inconsistent. The degree of weathering of the artifactual materials is probably a valid means of establishing their relative ages, but the degree of weathering depends on rock type and the situation under which different flakes were buried. For example, flakes buried under conditions that allowed moisture to reach them would be more intensely hydrated than would flakes buried in a deeper or drier environment. Furthermore, the exposure to wind abrasion depends on

TABLE 18

Size analyses of sediment samples collected at China Lake, California, Stake 1, Trench 3.
Sampled November 9, 1974 by G. I. Smith and E. L. Davis; size analyses by G. Harris

Size (min)	Sample designation (Values as weight percent) A	B	C	D	E	Size Description
>4	3.2	9.9	0.2	14.5	0.6	Pebbles
2–4	10.8	37.6	4.3	26.4	4.7	Granules
1–2	11.2	19.9	9.6	26.2	9.2	Very coarse sand
0.5–1	13.0	11.8	17.6	18.5	11.9	Coarse sand
0.25–0.5	20.0	15.0	32.1	9.5	27.6	Medium sand
0.125–0.25	26.6	3.5	28.6	3.0	40.5	Fine sand
0.0625–0.125	12.2	1.3	4.2	1.1	4.3	Very fine sand
<0.0625	3.0	1.0	3.4	0.8	1.2	Silt and clay

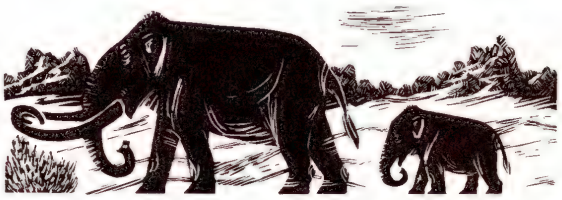
age, exhumation and the direction in which the flake faces. Therefore, the amount of weathering that is preserved may vary greatly and lead to incorrect interpretations.

The lake that existed between 2,000 to 6,000 years ago in Searles Basin was peculiar in that it only rose about 140 feet above the present floor of the valley. This is the lake, however, that represents a minor pluvial period which we believe is the cause of the lacustrine deposits that make the so-called ''capping sandstone'' in China Lake. The only good date on these deposits in Searles Lake comes from a piece of wood, found near in the middle of this unit, which had an age of 3,520 ±190 years (Stuiver 1964). Other areas that have better control on dating commonly report a pluvial event beginning about 4,000 to 6,000 years ago, and ending about 2,000 to 3,000 years ago; this is the event that I correlate on a climatic basis with the lake in Searles Valley and China Lake.

Chapter 8
THE LAKE CHINA RANCHOLABREAN FAUNULE

By David E. Fortsch[9]

The Fossils



The China Lake fossil vertebrate fauna thus far known from Indian Wells Valley in the northern Mojave Desert of southern California, although comprised of relatively few taxa, nevertheless provides important clues concerning the late Pleistocene environment and paleoecology of the region. Since fossil vertebrates from a known Mojave locality were first collected in the early part of the twentieth century (Baker 1911; Merriam 1911), many important localities and faunas have been found. Only three from the northern or central Mojave are Pleistocene and of these but one, the Schuiling Cave fauna of Downs and others (1959), falls with certainty into the same late Pleistocene time frame occupied by the China Lake assemblage. The Airport Dry Lake Fauna collected by Tedford from the White Hills in the northern end of Indian Wells Valley (Von Huene 1971; Miller 1965), though geographically closer than Schuiling Cave, is geologically older, being early-to-middle Pleistocene.

Although a few isolated vertebrate fossil specimens from the lower reaches of Indian Wells Valley have made their way to museum collections, the area has been largely ignored by vertebrate paleontologists. This doubtless resulted from the fact the valley lies within the basin and range geomorphic province, an area characterized by closed basins and centripetal drainage. Workers probably assumed any specimens present were being ever more deeply buried by sediments derived from the surrounding mountains and indeed, the work of Zbur (1963) indicates up to 6200′ of unconsolidated alluvium fills some parts of the valley. If I have properly interpreted the geomorphology and limited topography of the valley floor however, post-Pleistocene deflation has removed in excess of 1 km^3 of sediment from the valley thereby exposing many fossils. As sediments are removed the fossils move vertically downward creating "artificial" concentrations.

China Lake fossils are associated with alluvium and lake sediments indicative of cooler and wetter conditions than currently prevail. At some places within the collecting areas skeletal fossil soils occur (see commentary of G. I. Smith, this volume), but relatively few vertebrate fossils are found with them. Although bones do occur throughout the sediments forming the limited topography present, most are associated with an alluvium layer immediately overlying cross-bedded nearshore lacustrine deposits. Three areas within the valley have thus far produced the bulk of the late Pleistocene fossil vertebrates and future work will doubtless produce additional sites and specimens.

The first of these sites, LACM vertebrate locality 7013, is a large area, slightly over 11 km^2 in extent, containing a diffuse surface scatter of bone fragments. It occupies parts of sections 20, 21, 27, 28, 33 and 34, T. 25 S., R. 40 E., and site elevations range from 2160 to 2215 feet above sea level.

The second vertebrate locality, designated LACM 7262, occurs in section 6, T. 26 S., R. 41 E., and is smaller than 7013 in all respects. Stratigraphically below 7013 and lying at a lower elevation as well (2152′ msl), it has produced a lesser number of vertebrate fossils. Depending upon how much and how recently rain may have fallen, it is near or slightly below groundwater level.

The third and most recently discovered site, LACM 3569, lies some miles to the north-northwest of the other two in section 35, T. 24 S., R. 39 E. at approximately 2210′ (we have actual elevation on this) elevation. It is somewhat larger in area than 7262 but has produced fewer specimens. In all probability many more items will be found with time. Sites 7013 and 7262 can be seen on the USGS Ridgecrest, California

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15′ topographic quadrangle map and 3659 can be located on the Mountain Springs Canyon 15′ topographic quadrangle.

No fossil material found is unaltered. The replacement of bone tissue by calcium carbonate ($CaCO_3$) during the process of premineralization probably occurred a relatively short time after burial and proceeded slowly since minute structural detail is preserved in some instances. A ten percent solution of hydrochloric acid (HCl) applied to the surface of specimens produces vigorous effervescence; stronger solutions will dissolve small fragments in a short time. It is interesting to note that percolating groundwaters have subsequently deposited other minerals, probably silicates, in the deeper bone lacunae and foramena and that clay minerals frequently fill those nearer the surface. When a specimen is dissolved slowly many of these extremely fragile secondary deposits remain to mark the paths of the lacunae. Color of the fossil bones ranges from chalky white to an enameled black with browns and greys predominating. Several colors may occur in a single specimen.

The normal agents of skeleton destruction and dispersal, water, wind, ice, humic acids, predators and scavengers, destroyed most materials before fossilization could occur. Of the small percentage which became fossils, the greatest portion is probably broken up by the growth of evaporite mineral crystals in the near surface environment before being found. The relatively few that survive both the initial hazards and subsequent crystal growth and are collected have usually developed a patination of desert varnish and almost always show evidence of sand blasting. A number of large specimens, for example several associated elements from a mammoth skeleton, were reasonably complete below ground level but had been planed off at the surface by blowing sand. Fragments of ivory from this same specimen were recovered over 100 meters away in a down-wind direction.

As would be expected, small dense items of uniform composition are those that most often survive and are found. Even these may be broken into three or four pieces and must be mended before identification is possible. The effects of sandblasting after exposure are such that even though fragments almost surely representing the same element are found associated, the edges are often so rounded and worn they cannot be fitted together. Elements having dense outer bone surrounding a large medullary cavity or cancellous tissue break down into fragments difficult to recognize and frequently impossible to reconstruct. The differing densities of enamel, dentine and cement make teeth the most susceptible of all skeletal elements to crystal growth destruction, however. Further, the generally small size and thinness of most tooth fragments makes transport by the infrequent rains or the more common windstorms easy and results in quick scattering of fragments.

Because of time spent and area involved, the 7013 locality has produced the largest fraction of the China Lake fauna. Not all of the 11+ square-kilometer area has been minutely examined, but only those ''stakes'' illustrated and discussed by Davis in the archaeological section of this paper. Doubtless collections larger both numerically and taxonomically would have resulted if the entire area had received equal attention. The careful mapping of bone occurrences especially in this area made possible recognition of factors effecting paleontological interpretations which might otherwise have escaped notice. For instance, the bone plots led to increased awareness of topography in the nearly featureless landscape and, in turn, to recognition of the association of bones with fossil soils and sediments and of stratigraphic relationships.

In most instances collection of paleontological specimens involved simply picking them up, recording locality data and preparing them for transport. In those relatively few instances involving larger or fragile specimens standard excavation procedures and construction of protective plaster casts to facilitate safe transport were followed.

Locality 7262 was discovered relatively late in the paleontological phase of the investigation and produced a more limited faunule as a result. Its specimens were found in sidewall sediments and in backdirt from an excavation connected with a project of the China Lake Naval Weapons Center. Though totaling far fewer items, the 7262 specimens comprise well over half the sum of small and/or delicate vertebrate fossils thus far recovered at China Lake. Among factors probably significant in this regard are the more constant moisture conditions (at or below groundwater level) and a lesser period of exposure to subaerial weathering. The water oriented faunule recovered here coupled with the much finer sediments suggest an off-shore lacustrine depositional environment. There is no hint of the ''vertical enrichment'' noted in the 7013 area.

Although the least amount of time has been spent at locality 3659, work there has nevertheless produced interesting and significant results. Excavations have wrested several specimens of fossil proboscidean as well as rodent, carnivore and horse from a resistant calcareous duricrust. The higher elevation of the locality, approximately 50′ above the other two, and somewhat less permeable sediments, (caliche indurated fine-grained alluvium as opposed to cross-bedded sands) may be partly responsible for the relatively good condition of even large items. A nearly complete proboscidean mandible lacking only part of the inferior border and portions of the ascending rami is a fine example.

Of probably greater significance, however, is a microtine rodent jaw, first fossil representative of the Order Rodentia recovered at China Lake, and possibly identifiable to species. It is most unfortunate the 3659 segment of the fauna has been so incompletely collected and studied.

A list of the taxa recognized in the China Lake Fauna occurs in Table 19.

TAXA PRESENT AT CHINA LAKE

OSTEICHTHYES.—Only a single fragment of fish bone has been recovered to date. It is so small and undiagnostic as to preclude identification beyond class level. Nevertheless, its presence in lakebed sediments positively establishes the presence of an aquatic environment capable of supporting vertebrate life.

AMPHIBIA.—Although we tend to think of anurans as associated with water, this is not always the case. And while they usually return to water at least for reproductive purposes, it is not invariably so (Blair 1968 and others). The fact the single anuran specimen in the fauna was collected from the offshore lacustrine sediments at LACM 7262 strongly suggests a water-associated form and strengthens the aquatic environment established by the fish bone.

TABLE 19

China Lake Faunal List by site		7013	7262	3659
OSTEICHTHYES				
Unidentified fish			X	
AMPHIBIA				
Undetermined frog			X	
REPTILIA				
Undetermined turtle		X	X	
AVES				
Aechmorphus			X	
Phalacrocorax		X		
Anas		X	X	
Aythya		X	X	
Branta		X		
Cygnus			X	
Oxyura		X		
Aquila		X		
Haliaeetus			X	
Fulica			X	
Grus		X		
Undetermined bird		X		
MAMMALIA				
Canis		X	X	
Smilodon		X		
Undetermined felid		X		
Undetermined carnivore		X		X
Equus		X	X	X
Hemiauchenia		X		
Camelops		X		
Odocoileus	X	X		
Bison		X		
Mammuthus		X		X
Microtus				X

REPTILIA.—The Class Reptilia is represented by two turtle specimens, one questionable. On the basis of the limited and fragmentary material available a determination of terrapin or tortoise, as these terms are generally used, cannot be made. Either or both are possible.

AVES.—Eleven genera of birds are thus far recorded in the Pleistocene China Lake Fauna, and none is today extinct. Nine of the 11 represented forms are water birds, coots, cranes, cormorants, ducks, geese, grebes and swans. The remaining two are both raptors. One is probably a bald eagle, the other a golden eagle. Bald eagles are known to feed preferentially upon dead and dying fish, again a water-association. The golden eagle, while less strongly associated with water, is nevertheless frequently found near lakes or streams.

MAMMALS.—China Lake fossil mammals range from large to small—elephants to mice. Although exact ratios cannot be determined with the material available, herbivores far outnumber carnivores as would be expected in a normal prey-predator relationship.

The terrestrial carnivores are represented by the dog and cat families. The genus *Canis* encompasses wolves and coyotes, both of which are present, whereas among the felids the only genus surely identified is *Smilodon,* the sabretooth. Additional cat material is too undiagnostic for generic allocation, and from the 3659 locality there is a deciduous incisor not determined beyond carnivore.

Herbivores present include horses among the Perissodactyla, camels, deer and bison from the Artiodactyla, mammoths from the Proboscidea and a microtine from the Rodentia. On the basis of numbers of specimens recovered, camels were most numerous, followed by horses, bison, mammoths, deer and rodents. In point of actual numbers living in the area at any one time, however, their relative abundances probably were quite different. Frequency of occurrence of the various groups in the fossil record depends upon many factors, including size of animal, size of element, life style, number of similar elements in the body, number of individuals, to name a few, so that number of specimens finally available for study is largely an accident of preservation. These factors materially increase difficulty of interpreting prey-predator relationships as well.

ECOLOGY AND AGE

Consideration of the various taxonomic groups present and relative numbers of individuals within each produces a picture neither clear nor easy to interpret. The large percentage of water associated birds coupled

with the lacustrine sediments at 3659 strongly supports Gale's (1914) conclusions regarding Pleistocene lakes, and further suggests the comparatively undiagnostic anuran and chelonid materials collected represent aquatic rather than terrestrial forms.

The numbers of strictly terrestrial forms, and especially the high percentage of camels, horses and bison, leave no doubt there were extensive grasslands in the vicinity. Deer, and to a lesser degree proboscideans with high laminar frequency, suggests brush and trees. Specimens representing only a few proboscideans have been collected, but they no less than the bison, carry temporal as well as ecological significance. Various authors, among them Hibbard (1965) and others, place the first appearance in North America of both bison and mammoths during the Kansan glacial epoch or later. A preliminary age determination on fossil ivory from an *in situ* mammoth of 18,600 ±4,500 years BP (Davis 1972, personal communication) indicates the fauna is even more recent.

Few specimens representing the carnivores have been collected. However, assuming application of the prey-predator ratios recorded by Allan and Mech (1963) are valid for the fossil prey-predator megafauna picture at China Lake, a greater percentage of carnivores would be expected. Quite probably many have gone undetected because of fragmentation and poor preservation.

Comparison with other Southern California Faunas

The three faunules that combine to form the China Lake Fauna contain 20 recognized genera and 6 groups not yet determined to generic level. Comparison with fossil assemblages from surrounding areas shows it is most like the Rancho La Brea fauna from the "tar" pits of the Los Angeles Basin.

Miller (1971) discussed nearly 60 vertebrate fossil localities in the Los Angeles Basin exclusive of Rancho La Brea five in some detail. Though his sites cover a much longer time span, nearly the whole Pleistocene, and have a much larger composite fauna, there are still a few genera recorded at China Lake that have not been found at his sites.

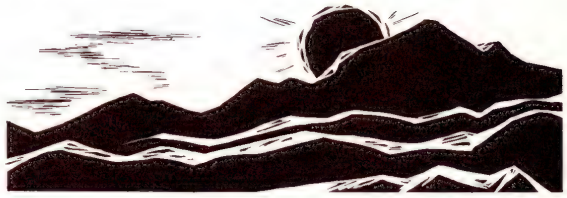
Other central California sites show still less faunal similarity. Among them are the previously mentioned Airport Dry Lake fauna (Mid-Pleistocene) from the north end of Indian Wells Valley, the Coso Mountains fauna (Late Pliocene to Early Pleistocene), the Ricardo (Miocene/Pliocene) and Goler (Paleocene) faunas from the El Paso Mountains, the Death Valley Titus Canyon fauna (Oligocene) and the Cache Peak and Phillips Ranch faunas (Miocene) from the Tehachapi Mountains. Of these, the closest geographically, temporally and faunally was that from Airport Dry Lake with four genera, which are found at China Lake.

Schuiling Cave near Newberry, California produced a fauna containing 9 of the same genera as those present at China Lake though geographically more distant. Its fauna is probably closer in time to that from China Lake, and may be even more recent since there was a possible association of charcoal and artifacts with faunal elements in the upper layers of the deposits.

All things considered, it is quite clear the Rancho La Brea fauna from the "tar" pits of Los Angeles brackets that from China Lake in time and shows the greatest faunal similarity as well. The China Lake assemblage is a Rancholabrean fauna.

Chapter 9
CONCLUDING REMARKS

By Emma Lou Davis and Carol Panlaqui



Summary

During five years of weekend field work in China Lake Basin, we approached the Mojave Desert with work philosophies and practical strategies different from those that customarily have been used. We viewed the desert as a whole environment and the scraps of PaleoIndian ''signs'' as part of a total life-style within this ecosystem. Also, we were forced to devise simple, intensive tactics of mapping, spotting, recording and collecting stone and bone (see Davis 1975). By treating the Mojave as delicately as though it were a French cavern, we were able to squeeze a small amount of cavern information out of it—for it is an open ''cavern'' with refined layering. This was our major discovery. Therefore, we harvested unaccustomed information and generated deviant hypotheses to explain it.

This report is a first scan of a large corpus of unreported data. It is highly experimental. Postulates and their corollaries have evolved along growth lines of speculation, leading to unexpected and unifying possiblities.

The Lake

Lake China was probably a seasonal use-area—during the spring and fall bird seasons? People chose to live along marsh/grassland interfaces, exploiting the full range of food and industrial resources. By using information about preferred habitats of the Lake China faunas, particularly the avifauna, an optimal biome can be reconstructed: a shallow, windstirred, fresh water lake; marshes, sloughs and sluggish streams surrounding the lake; some gallery forests or lakeside trees. These aquatic habitats were surrounded, at times, by a tall-grass savanna, capable of supporting a limited population of very large grazers: Columbian mammoths; two species of horse; two species of camel; *Bison antiquus*. These were preyed upon and scavenged by dire wolves, saber tooth cats and coyotes. This was grassland, not brushland, for we found among the more than 850 bones only one specimen of a browser, a deer. However, during the heights of the stadials, the environmental background of Lake China was evidently a cold steppe with some xeric, desert forest such as juniper, (see Mehringer, this volume).

Since Lake China fluctuated extremely and frequently, the relative positions of the interfaces shifted accordingly. There probably is scarcely an acre of ancient soil surface which was not, at some time, used as a camp or work locus by a few people. Such occupancy evidently continued, sporadically, from about 45,000 years ago until about 5,000 BP.

Discoveries

1) The desert basin of Pleistocene Lake China is stratified, and in these stratigraphies, fossil soils are the keys to knowledge of the people and animals. In their day, the old soils were habitat floors; now, as fossils, they support residual bones and artifacts.

2) The PaleoIndians here were not primarily mammoth eaters. They were general foragers who occasionally killed a large herbivore in the following order of frequency: camel; horse; bison—and last of all mammoth.

3) Distribution of ''Clovis points'' (more likely fluted knives) suggests that these implements in the Lake China area were used for butchering animals rather than for killing them.

4) The roots of Clovis, previously unknown, appear to have been in the Great Basin. In the Lake China Valley, Clovis tool forms were the products of two cultural lineages: a Lanceolate Tradition (which generated this segment of a Fluting Cotradition) and an Ovate Tradition (which seems to have also been expressed in a Western Lithic Cotradition) (see Fig. 81). The Ovate Tradition is ancient and may be of Siberian

derivation. The Lanceolate Tradition begins with Proto-Clovis, characterized by replacement of irregular percussion flaking with a regularized, wide-flake percussion, pressure retouch, and short, multiple, basal flutes. These knives have a single, almost imperceptible shoulder and the blade is curved on the opposite side. They are heavily weathered.

5) In Lake China Valley, Classic Clovis is only slightly weathered. This phase of the Fluting Cotradition has three technological signatures:

1) selection of highest quality materials from distant sources;
2) Heat tempering of the stone;
3) exquisite workmanship.

6) Three Desert Culture traits seem to derive from PaleoIndian Cultures of the Great Basin. The practices are milling; basketry; and making of fur-string and feather-string garments. These operations are inferred from three classes of PaleoIndian implements, which are abundant on the sites: pounding/grinding rocks; microspokeshaves; and small, asymmetrical flake cutters. These latter ones form a part of the Core Tool Tradition toolkit and some appear to be very old.

7) Relative degree of weathering is an important and consistent criterion of relative age of Lake China artifacts. Chemical and physical weathering express the number of times a tool has been re-exposed after burial as well as the composition of the soil in which it lay originally. Tool groups in this valley have been tentatively classified, therefore, into the following facies (see Table 1): Core Tool Tradition (extremely weathered); Late Wisconsin Cultures I (heavily weathered); Late Wisconsin Cultures II (heavily weathered); Proto-Clovis (heavily to moderately weathered); Classic Clovis (slightly sandblasted); Pinto (almost unaltered).

8) Stone industries of PaleoIndians who visited Lake China were all flake industries—from Core Tool Tradition to Classic Clovis. Most tools were made on camp-trash flakes; every flake that could be held or hafted was used; old camps were systematically scrounged for flakes, which could be re-used. The reason is simple. It was at least a long day's hike to the nearest quarry.

Postulates and Corollaries

The immense size of our sample (about 20,000 stone objects) and the close controls provided by site maps have generated a number of propositions about Paleo-Indian lifestyles and cultures. These are listed, below, as a series of postulates with derived corollaries.

1. The major decision of a foraging people is the piece of land on which it chooses to live or work.

1:1 (Corollary). Land choice is a primary subsistence choice. It summarizes the totality of People/Environment relations at that time and that place.

2. In the Lake China context, these choices consistently point to a Primary Marsh Orientation. Marshes are fertile ecosystems. They offered early foragers both a large biomass and a bog-trap for large herbivores.

2:1 (Corollary). Once this land-use orientation is set up as a deductive base, all minor artifacts (such as stone tools) should fall into simple and meaningful relations. The tools were made to use in a particular environment, with its given assets and toward cultural goals.

3. As an artifact descriptor, "Lake Mojave Complex" is too diffuse a term and needs more precise definition and study in order to be subdivided and incorporated into a larger scheme.

3:1 (Corollary). Lake Mojave pseudo-points include end scrapers; cutters; knives; bunts; beaks and a few weapons.

3:2 (Corollary). The (unstudied) Lake Mojave implements generally occur close to Lanceolate Tradition knives and their accompanying toolkits are indistinguishable.

3:3 (Corollary). It, therefore, appears that "Lake Mojave" tools and "Clovis" tools are culturally similar but functionally somewhat different. That is, members of the same little band of people made and used both but for different tasks.

3:4 (Corollary). It is possible that "Clovis" knives and the "Lake Mojave" assortment were designed for man's work and women's work. This proposition should be checked against the tools themselves and against their distributions on the plane table maps.

4. The southern Great Plains of 21,000 to 14,000 years BP were a boreal forest, not a grassland (see Wendorf 1975:viii).

4:1 (Corollary). During this interval, the Great Basin Lakes Country (Fig. 82) was probably a cold steppe with grasses. It would, therefore, have been a more inviting habitat for people and herbivores than the dark forest during much of the Late Wisconsin.

4:2 (Corollary). If 4:1 is true, then an Intermontane corridor in the Basin should be the most productive avenue in which to trace Late Wisconsin Asia-America immigration and spread as shown in Fig. 82.

4:3 (Corollary). If animals of the savannas, followed by people, began to radiate eastward rapidly as the forests retreated, THEN THIS WOULD EXPLAIN THE SUDDEN EMERGENCE OF CLOVIS HUNTING GROUPS WITH A BASICALLY SIMILAR TECHNOLOGY. Byers (1954:344–350) was impressed by the technical unity between such sites as Shoop; Bull Brook; Lindenmeier and Williamson, where comparable fluted artifacts, gravers, drills, end-scrapers, side-scrapers and blades (?) were found.

The remarkable similarity between the complexes at these four sites can mean only one of two things—either people were extremely conservative in their work habits, or they spread much more rapidly than we have been willing to believe. If both the above are true, then everyone is somewhat correct: Byers, Haynes and ourselves. What we have been able to do, because of the scope of the Program and the size of our sample, is to propose a hearth and a history for Clovis.

5. Early populations were thin (1 person per 100 km^2 ?)

6. By 15,000 years BP the New World had considerable cultural and linguistic diversity.

6:1 (Corollary). If this is true then buried or exposed remnants of increasingly old paleosols should be one of the places to look for verification.

7. To trace the tenuous threads of early prehistory, two attacks are needed: 1) Total Archaeology—the use of every discipline, particularly geology; 2) Regional Sampling—a very broad study, like this one, of a lifeway or one of its seasonal foci. This must be done in breadth. This cave or that site will not suffice.

8. Let us say more of caves and their informations. There are two categories of sites available in the Intermontane West: closed sites (caves and rockshelters) and open sites (work or habitation spaces under the sky).

8:1. Both categories can be further broken down into subclasses: ''exposed'', ''buried'' and ''eroding'' (which combines both). As an example, most China Lake sites are in process of eroding.

8:2. Open sites have great advantages. They can be comparatively sampled across different ecosystems. Open sites are where people did most of their living and therefore, are more informative in respect to lifestyles and adaptations to special challenges.

8:3. Rockshelters, with their more limited and specialized input give a skewed version of a culture, if not combined with an open site sample.

8:4. This first segment of the China Lake Program work is an example of open site, wide space sampling. It has partially investigated a seasonal focus of many small PaleoIndian bands, probably during the spring and fall when birds were migrating and nesting. Because many of the loci were occupied several times during thousands of years, a dimension of time and another dimension of cultural dynamics have been added to the spatial breadth of the studies.

9. Many styles of PaleoIndian knife/points are found in the Lake China valley. The following sequence is tentatively proposed for them (Fig. 81).

a) Cordiforms (very early), possibly Mousteroid in origin
b) Long, thick ovates (also early)
c) Single shouldered, long ovates, which are thinner
d) Proto-Clovis, single-shouldered, lanceolate knives
e) Proto-Clovis, single-shouldered lanceolate knives with flutes on both sides
f) Clovis of Lanceolate Tradition
g) Clovis of Ovate Tradition
h) Classic Clovis
i) Degenerate Clovis (''Humboldt Concave Base''?)
j) Pinto
k) A few Milling Archaic specimens.

EARLY MIGRATIONS

PaleoSiberians probably began trickling into Alaska and then down the Americas during a major interstadial 70,000 years ago. Traces of this period are virtually non-existent. By 45,000 years BP an interval of milder, rapidly oscillating climate began in the Lake Searles-Lake China area and the basins would have been good habitats during optimal periods in the fluctuations of water levels and climate. At this time, the Great Plains might have been a prairie land like today. The west coast of California, the Great Basin and the Plains would, then, have been open roads toward Meso-America and South America.

Once people became established in the Great Basin, it was never abandoned, although selection of habitats was determined by ecological factors. The Basin and the California deserts were a sump, a cultural pool where technological change and other developments took place. Some people continued to drift south into Baja California and the West Coast of Mexico. Some tarried for longer or shorter times, and new ones were added. Both new techniques of exotic character and those that evolved autochthanously are detectable, archaeologically, on Lake China sites. These developments are best shown in a drawing (see Fig. 81).

The cultural strands which can be most clearly recognized are these: a Core Tool Tradition followed by an Ovate Point tradition. Both are complexes of tools manufactured by irregular percussion. The Lanceolate Tradition then appears with long, fluted, slightly shouldered knives and a different technology. Rough percussion is replaced by the regularized removal of broad and very shallow pressure flakes and edges are lightly retouched. The next innovation is seen in the appearance of a few blades, microblades and microblade cores. In the penultimate stage of PaleoIndian use of Lake China shores, peoples of the Classic Clovis phase brought stone technology to a peak, and either received or invented heat tempering of fine quality

stone. Otherwise, their knapping techniques were much the same as those used to manufacture the Lanceolate Tradition long knives, possibly 5,000 years earlier.

After this, the thread of cultural development is lost in this valley and we must look elsewhere for continuities.

Throughout this report, it has been assumed that the best explanatory hypotheses have three features:

a) they are the simplest;
b) they best fit the most data;
c) they offer the greatest unifying presentation.

RECOMMENDATIONS FOR FUTURE STUDIES

The hypotheses that have been generated in this report must be assiduously tested in special studies:

a) Tests of the cultural chronology shown in Table 9.
b) Tests of cultural diversity in the New World by 15,000 years BP.
c) The validity of weathering of the artifacts as a criterion of their age must be carefully scrutinized from all possible angles.
d) A major hypothesis involving population flow from the Mojave Desert into Mexico and Arizona, about 12,000 years ago, must be exhaustively tested in a search for Proto-Clovis; Clovis and "Sandia" connections.

In addition, a number of specific projects are proposed as steps in a long-range research program in this portion of the Basin and Range geomorphic province:

I. *Detailed microstudies of stone tools.*
   a) Manufacturing technology.
   b) Use and re-use wear-patterns.
   c) Association of each artifact class with particular portions of the living areas.
   d) Investigate further the cultural sequences in Lake China basin: what are their toolkits; their ages; their connections with one another and with other marsh adaptations in the Great Basin?
   e) Further explore Desert Culture and Archaic Indian cultural traits, which are deeply rooted in the New World Paleolithic.
   f) Study lithic sources and routes of travel over which exotic materials were brought into the valley.

II. *Geological studies and mapping.*
   a) Identify and distinguish the upper four paleosols by deeper trenching at Stake 1, Stake 25 and the Basalt Ridge.
   b) Connect these 4 soils with different types of flaggy sandstone, if possible.
   c) Map the configurations of these soil indicators over the entire Intensive Test Area. Contiguous areas should be included in this broad program to identify large scale patterns.
   e) Explore and map thoroughly the entire M-184 Basalt Ridge area to elucidate PaleoIndian land use patterns.

III. *Paleontological studies.*
   a) A study of differential extinction of camel; bison; horse and mammoth in the Lake China Valley.
   b) A study of the circumstance of deposition of various kinds of bone by association with their Munsell color; degree of attrition; and particle size of the matrix.
   c) Further explorations in the area of the present lake (LACMNH locality 3659) for faunal, palynological, geological and radiometric information.

IV. *Palynological studies.*
   a) Further areal pollen studies in adjoining valleys, ranges and springs.

V. *Statistical studies.*
   a) This very large sample of information is ideal for seriation of artifacts and scaling of sites.

VI. *Culture-theory.*
   a) Concepts of a Fluting Cotradition (which includes the Lanceolate Tradition of knife/points); and of a Western Lithic Cotradition (including an Ovate Tradition of points) must be revised.

LITERATURE CITED

ADAMS, R.M. 1968. Archaeological research strategies: past and present. Science, 160(3833):1887–1192.

ADOVASIO, J.M., J.D. GUNN, J. DONAHUE AND R. STUCKENRATH. 1975. Excavations at Meadowcroft Rockshelter 1973–1974: a progress report. Pennsylvania Archaeologist, 45(3):1–30.

AIKENS, C.M. 1967. Excavations at Snake Rock Village and the Bear River No. 2 site. Univ. of Utah, Anthropol. Paper 87. Salt Lake City, Utah, 65 pp.

ALDRICH, S. AND J. BINDER. 1972. A description of some comparative cultural remains of early man from Mexico and New York State. Yager Mus. Pubs. in Anthro., Bull. 4:15–23.

ALEXANDER, H.L., JR. 1963. The Levi Site: a PaleoIndian campsite in central Texas. Amer. Antiq., 28(4):510–528.

ALLEN, D.L. AND L.D. MECH. 1963. Wolves versus moose on Isle Royale. Nat. Geog., 123(2):200–219.

AMSDEN, C.A. 1937. The Lake Mohave artifacts. *In:* The archaeology of Pleistocene Lake Mohave a symposium, E.W.C. Campbell, W. Campbell, E. Antevs, C.A. Amsden, J.A. Barbieri and F.D. Bode. Southwest Mus., Pap. 11:51–97.

BADA, J.L., R.A. SCHROEDER, R. PROTSCH AND R. BERGER. 1974. Concordance of Collagen-based radiocarbon and aspartic acid racemization ages. Natl. Acad. of Sci., U.S.A. Proc. 71(3):914–917.

BADA, J.L., R.A. SCHROEDER AND G.F. CARTER. 1974. New evidence for the antiquity of man in North America deduced from aspartic acid racemization. Science, 184(4138):791–793.

BADA, J.L. 1975. Racemization dating of early human skeletal remains. Thirteenth Pac. Cong., Abstracts of Papers, 368.

BAKER, C.L. 1911. Notes on later Cenozoic history of the Mojave Desert region in southeastern California. Univ. Calif. Publ., Dept. Geol., Bull., 6: 333–383.

BLAIR, W.F., A.P. BLAIR, P. BRODKORB, F.R. CAGLE AND G.A. MOORE. 1968. Vertebrates of the United States (2d ed.). New York, McGraw-Hill, 616 pp.

BOGORAZ, W. 1903–1904. The Chukchee, I, II and III. Amer. Mus. Nat. Hist., Mem. 11:1–733.

BORN, S.M. 1970. Deltaic sedimentation at Pyramid Lake, Nevada. Ph.D. thesis, Univ. of Wisconsin, 1–234.

BROECKER, W.S. AND A. KAUFMAN. 1965. Radiocarbon chronology of Lake Lahontan and Lake Bonneville II, Great Basin. Geol. Soc. Amer. Bull., 76(5):537–566.

BRYAN, A.L. 1965. Paleo-American prehistory. Idaho St. Univ., Oc. Pap. 16:1–247.

———. 1975. Paleoenvironments and cultural diversity in late Pleistocene South America: a rejoinder to Vance Haynes. Jour. Quat. Res., 5:151–159.

BUTLER, B.R. 1961. The Old Cordilleran Culture in the Pacific northwest. Idaho St. Coll. Mus., Oc. Pap. 5:1–102.

BYERS, D.S. 1954. Bull Brook—a fluted point site in Ipswich, Massachusetts. Amer. Antiq., 19(4):343–351.

———. 1966. The Debert archaeological project: the position of Debert with respect to the Paleo Indian tradition. Quaternaria, 8:33–47.

CAMPBELL, E.W.C. AND W.H. CAMPBELL. 1935. The Pinto Basin site. Southwest Mus., Pap. 9:1–5.

———. 1936. Archaeological problems in the southern California deserts. Amer. Antiq., 1(4):295–300.

———. 1940. A folsom complex in the Great Basin. Southwest Mus., Masterkey 14(1):7–11.

CAMPBELL, E.W.C., W.H. CAMPBELL, E. ANTEVS, C.A. AMSDEN, J.A. BARBIERI AND F.D. BODE. 1937. The archaeology of Pleistocene Lake Mojave: a symposium. Southwest Mus., Pap. 11:1–118.

CLEWLOW, C.W. JR. 1968. Surface archaeology of the Black Rock Desert. *In:* Papers on the archaeology of the western Great Basin. University of Calif., Archaeo. Surv., Rept. 73:1–93.

CRABTREE, D.E. 1966. A stoneworker's approach to analyzing and replicating the Lindenmeier Folsom. Tebiwa, 9(1): 1–3.

CRABTREE, D. AND B.R. BUTLER. 1964. Notes on experiments in flint knapping: I. Heat treatment of silica materials. Idaho St. Univ. Mus., Tebiwa, 7(1):1–6.

CROFT, M.G. 1968. Geology and radiocarbon ages of late Pleistocene lacustrine clay deposits, southern part of the San Joaquin Valley, California. U.S. Geol. Survey Prof. Pap. 600-B:1–151.

CROOK, W. AND R.K. HARRIS. 1958. A Pleistocene campsite near Lewisville, Texas. Amer. Antiq., 23(3):233–246.

CUSHING, F.H. 1920. Zuni breadstuff. Heye Foundation, Indian Notes and Monographs, 8:1–673.

DAUGHTERTY, R.D. 1956. Archaeology of the Lind Coulee site, Washington. Am. Phil. Soc., Proc. 100(3)223–278.

DAVIS, E.L. 1963. The desert culture of the western Great Basin: a lifeway of seasonal transhumance. Amer. Antiq., 29(2):202–212.

DAVIS, E.L. AND R.F. LOGAN. 1965. An ethnography of the Kuzedika Paiute of Mono Lake, Mono County, California. Univ. Utah Anthro. Pap. 75:1–55.

DAVIS, E.L. AND S. WINSLOW. 1965. Giant ground figures of the prehistoric deserts. Am. Phil. Soc., Proc. 109(1): 8–21.

DAVIS, E.L., C.W. BROTT AND D.L. WEIDE. 1969. The western lithic cotradition. San Diego Mus., Pap. 6:1–97.

DAVIS, E.L. AND R.S. SHUTLER. 1969. Recent discoveries of fluted points in California and Nevada. Nevada St. Mus., Anthrop. Pap. 14(7):154–177.

DAVIS, E.L. 1973. The Hord site, a PaleoIndian camp. Pacific Coast Archeol. Soc., Quar. 9(2):1–26.

———. 1974. PaleoIndian land use patterns at China Lake, Calif. Pac. Coast Archeol. Soc., Quart. 10(2):1–16.

———. 1975. The "exposed archaeology" of China Lake, California. Amer. Antiq., 40(1):39–53.

DEEVEY, E.S., JR., M.S. GROSS, G.E. HUTCHINSON AND H.L. KRAYBILL. 1954. The natural C14 contents of materials from hard-water lakes. Proc. Nat. Acad. Sci., 40:285–288.

DEREVYANKO, A. 1975. On the migration of ancient man from Asia to America. *In:* The Pleistocene Epoch. Thirteenth Pac. Sci. Cong., Abstracts of Papers, 372–373.

DI PESO, C.C. 1974. Casas Grandes: A fallen trading center of the Gran Chichimeca. J.F. Fenner (ed.). Amerind Foundation.

DOWNS, T., H. HOWARD, T. CLEMENTS AND G.A. SMITH. 1959. Quaternary Animals from Schuiling Cave in the Mojave Desert, California. Los Angeles Co. Mus., Contr. in Sci. 29, 1–21.

DUB, G.D. 1947. Owens Lake—source of sodium minerals. Mining Tech., 2(5):1–13.

DUTCHER, L.C. AND W.R. MOYLE, JR. 1973. Geologic and hydrologic features of Indian Wells Valley, California. U.S. Geol. Survey Water-Supply, Paper 2007, 30 pp.

EARDLEY, A.J. 1962. Gypsum dunes and evaporite history of the Great Salt Lake Desert. Univ. of Utah, College of Mines and Mineral Industries, Special Studies No. 2. Salt Lake City, Utah, 27 pp.

EARDLEY, A.J., VASYL GVOSDETSKY AND R.E. MARSELL. 1957. Hydrology of Lake Bonneville and sediments and soils of its basin. Geol. Soc. Amer. Bull., 68(9):1141–1202.

ELFORD, C.R. 1970. Climate of California. Climates of the States. Climatography of the U.S. 60–4, ESSA, Environmental Data Service, 57 pp.

FLADMARK, K.R. 1975. Feasibility of the Northwest Coast as a migration route for early man. Paper presented at the Thirteenth Pac. Sci. Cong., Vancouver, 1–24.

FORTSCH, D.E. 1972. A late Pleistocene vertebrate fauna from the northern Mojave Desert of California. University of Southern California Thesis presented to the faculty of the graduate school in partial fulfillment of the requirements for the degree of Master of Science (Geological Sciences), 1–151.

GALE, H.S. 1914. Salines in the Owens, Searles and Panamint basins, southeastern California: U.S. Geol. Survey Bull., 580(1):251–323.

GUILDAY, J.E. 1967. Differential extinctions during late Pleistocene and Recent times. *In:* Pleistocene extinctions: the search for a cause, P.S. Martin and H.E. Wright (eds.), 121–140.

HARDMAN, GEORGE AND CRUZ VENSTROM. 1941. A 100-year record of Truckee River runoff estimated from changes in levels and volumes of Pyramid and Winnemucca Lakes. Amer. Geophysical Union Trans., 22:71–90.

HARINGTON, C.R., R. BONNICHSEN AND R.E. MORLAN. 1975. Bones say man lived in Yukon 27,000 years ago. Canadian Geog. Jour., 9(1,2):42–48.

HARRINGTON, M.R. 1957. A Pinto site at Little Lake, California. Southwest Mus., Pap., 17:1–91.

HAURY, E.W. 1953. Artifacts with mammoth remains, Naco, Arizona. Amer. Antiq., 19(1):1–14.

HAYDEN, J.D. 1965. Fragile-pattern areas. Amer. Antiq., 31(2):272–276.

HAYNES, C.V. 1964. Fluted projectile points: their age and dispersion. Science, 145(3639):1408–1413.

_____. 1967. Carbon-14 dates and early man in the New World. *In:* Pleistocene extinctions: the search for a cause, P.S. Martin and H.E. Wright (eds.), 267–286.

HAYNES, C.V. 1967. Quaternary geology of the Tule Springs area, Clark County, Nevada. Pages 15–104. *In:* Pleistocene studies in southern Nevada, H.M. Wormington and D. Ellis, (eds.). Nev. State Mus. Anthropol. Papers, 13. Carson City, Nev.

_____. 1968. Geochronology of late Quaternary alluvium. *In:* Means of correlation of Quaternary successions, Roger Morrison and H.E. Wright, Jr., (eds.). INQUA VII Cong., 8:591–631.

_____. 1970. Geochronology of man-mammoth sites and their bearing on the origins of the Llano complex. *In:* Pleistocene and recent environments of the central Great Plains, W. Dort Jr. and J.F. Jones Jr. (eds.). 77–92.

HAYNES, C.V., D.C. GREY, P.E. DAMON AND R. BENNETT. 1967. Arizona radiocarbon dates VII. *In:* Am. Jour. Sci. Radiocarbon, 9:1–14.

HEIZER, R.F. AND M.A. BAUMHOFF. 1962. Prehistoric rock art of Nevada and eastern California. Univ. California Press.

HEMMINGS, E.T. 1970. Early man in the San Pedro Valley, Arizona. Univ. Microfilms, Ann Arbor, Michigan.

HESTER, T.R. 1973. Chronological ordering of Great Basin prehistory. Univ. California Archeol. Res. Facil., Contrib., 17:1–199.

HIBBARD, C.W., D.E., RAY, D.E. SAVAGE, D.W. TAYLOR AND J.E. GUILDAY. 1965. Quaternary mammals of North America. *In:* Quarternary of the United States, H.E. Wright, Jr., and D.G. Frey (eds.). Princeton Univ. Press, 509–525.

HUNT, ALICE. 1960. Archeology of the Death Valley salt pan. Univ. of Utah Anthropol. Papers No. 47. Salt Lake City, Utah, 313 pp.

HUNT, C.B. AND D.R. MABEY. 1966. Stratigraphy and structure, Death Valley, California. U.S. Geol. Survey Prof. Paper 494–A:1–162.

HUNT, C.B., T.W. ROBINSON, W.A. BOWLES AND A.L. WASHBURN. 1966. Hydrologic basin, Death Valley, California. U.S. Geol. Survey Prof. Paper 494–B:1–138.

IRVING, W.N. AND C.R. HARINGTON. 1973. Upper Pleistocene radiocarbon-dated artifacts from the northern Yukon. Science, 179(4071):335–340.

IRWIN-WILLIAMS, C. 1967. Association of early man with horse, camel and mastodon at Hueyatlaco, Valsequillo (Puebla, Mexico). *In:* Pleistocene extinctions, the search for a cause, W. Dort Jr. and H.E. Wright Jr. (eds.), 337–347.

_____. 1968. Valsequillo field conference report. Presented Paper, Geol. Soc. Amer. meetings. Mexico City.

JELINEK, A.J. 1966. An artifact of possible Wisconsin age. Amer. Antiq., 31(3):434–435.

JENNINGS, C.W., J.L. BURNETT AND B.W. TROXEL. 1963. Geologic map of California, Trona sheet. State of Calif., Div. of Mines and Geol., San Francisco, Calif.

JENNINGS, J.D. AND E. NORBECK. 1955. Great Basin prehistory: a review. Amer. Antiq., 21(1):1–11.

JUDGE, W.J. 1973. PaleoIndian occupation of the central Rio Grande valley in New Mexico. Univ. New Mexico Press, 1–361.

JUDGE, W.J. AND J. DAWSON. 1972. PaleoIndian settlement technology in New Mexico. Science, 176(4040):1210–1216.

KOLVA, D.A. 1975. Exploratory palynology of a scabland lake, Whitman County, Washington, Masters thesis, Washington State Univ., 1–43.

KUNKEL, F. AND G.H. CHASE. 1969. Geology and groundwater in Indian Wells Valley, California. U.S. Dept. Interior, Geol. Survey. Open file report prepared in cooperation with the Naval Weapons Center, China Lake, California, 1–84.

LAHREN, L. AND R. BONNICHSEN. 1974. Bone foreshafts from a Clovis burial in southwestern Montana. Science, 186(4159):147–150.

LEE, C.H. 1913. Ground-water resources of Indian Wells Valley, California. *In:* California State Conserv. Comm. Report. Sacramento, Calif., 401–429.

LORENZO, J.L. 1975. Early man in the American continent: appraisal and perspectives. Thirteenth Pac. Sci. Cong., Vancouver, Abstracts of Papers, 378–379.

LOWDON, J.A. AND W. DYCK. 1974. Seasonal variations in the isotope ratios of carbon in maple leaves and other plants. Can. Jour. Earth Sci., 11:79–88.

LYNCH, T.F. AND K.A.R. KENNEDY. 1970. Early human cultural and skeletal remains from Guitarrero Cave, northern Peru. Science, 169(3952):1307–1309.

MACNEISH, R.S. 1970. Second annual report of the Ayacucho archaeological-botanical project: 1–46. Ayacucho archaeological-botanical report 2. R.S. Peabody Foundation for Archaeology.

_____. 1971. Early man in the Andes. Sci. Amer., 224(4): 36–46.

MARTIN, P.S. 1973. The discovery of America. Science, 179(4077):969–974.

MARTINEAU, L.V. 1973. The rocks begin to speak. K.C. Publications.

MARWITT, J.P., G.F. FRY AND J.M. ADOVASIO. 1971. Sandwich Shelter. *In:* Great Basin Anthropological Conference, C.M. Aikens, (ed.). 1970, selected papers. Univ. of Oregon, Anthropol. Papers No. 1. Eugene, Oregon, 27–36.

MASON, R.J. 1962. The PaleoIndian tradition in eastern North America. Current Anthrop., 3(3):227–278.

MEHRINGER, P.J. JR. 1967a. Pollen analysis of the Tule Springs Site area, Nevada. *In:* Pleistocene studies in southern Nevada, H.M. Wormington and D. Ellis, (eds.). Nev. State Mus. Anthropol. Papers No. 13. Carson City, Nev., 129–200.

_____. 1967b. The environment of extinction of the late-Pleistocene megafauna in the arid southwestern United States. *In:* Pleistocene extinctions: the search for a cause, P.S. Martin and H.E. Wright, Jr., (eds.). Yale Univ. Press, New Haven and London, 247–266.

MEHRINGER, P.J. JR., AND C.W. FERGUSON. 1969. Pluvial occurrence of bristlecone pine (*Pinus aristata*) in a Mohave Desert mountain range. Jour. Ariz. Acad. Sci., 5(4):284–292.

MEHRINGER, P.J. JR., AND C.N. WARREN. 1976. Marsh, dune and archaeological chronologies, Ash Meadows, Amargosa Desert, Nevada. Nev. Arch. Survey Res. Report No. 6. Reno, Nev.

MERRIAM, J.C. 1911. A collection of mammalian remains from Tertiary beds on the Mojave Desert. Univ. Calif. Publ. Bull., Dept. Geol., 67:167–169.

MICHELSON, R.C. 1967. Pecked metates of Baja California. S.W. Mus. Masterkey 41(2):73–77.

MILLER, R.R. 1965. Quaternary freshwater fishes of North America. *In:* Quaternary of the United States, H.E. Wright, Jr. and D.G. Frey (eds.). Princeton Univ. Press, 569–581.

MILLER, W.E. 1971. Pleistocene vertebrates of the Los Angeles basin (exclusive of Rancho La Brea). Los Ang. Co. Mus. Nat. Hist., Sci. Bull. 10:1–124.

MOCHANOV, Y.A. 1975. The Paleolithic of Northeast Asia and the problem of the first peopling of America. Thirteenth Pac. Sci. Cong. Vancouver, Abstracts of papers, 380–381.

MONTAÑE, J. 1968. Paleo-Indian remains from Laguna Tagua-Tagua, central Chile. Science, 161(3846):1137–1138.

MORRISON, R.B. 1964. Lake Lahontan: Geology of southern Carson Desert, Nevada. U.S. Geol. Survey Prof. Paper 401:1–156.

_____. 1965. Quaternary geology of the Great Basin. *In:* The Quaternary of the United States, H.E. Wright, Jr., and D.G. Frey (eds.). Princeton Univ. Press, Princeton, N.J., 265–285.

MORRISON, R.B. AND J.C. FRYE. 1965. Correlation of the middle and late Quaternary successions of the Lake Lahontan, Lake Bonneville, Rocky Mountain (Wasatch Range), southern Great Plains, and eastern Midwest areas. Nevada Bureau of Mines Report 9. Univ. of Nev., Reno, 45 pp.

MOVIUS, H.L.J. 1949. The lower Paleolithic cultures of southern and eastern Asia. Am. Phil. Soc. Trans., 38(4):329–420.

MÜLLER-BECK, HANSJURGEN. 1966. Paleohunters in America: origins and diffusion. Science, 152(3726):1191–1210.

MUNDORFF, J.C. 1971. Nonthermal springs of Utah. Utah Geol. and Mineralogical Survey, Water-Resources Bull., 16:1–70.

ODOM, E.P. 1966. Ecology. Holt, Rinehart and Winston.

OLSON, I.U. 1972. The pretreatment of samples and the interpretation of the results of 14 C determinations. *In:* Climatic changes in the arctic areas during the last ten-thousand years, Y. Vasari *et al.*, (eds.). Ser. A, Geol. No. 1, Acta Oulu Univ., Oulu, Finland, 9–34.

ORE, H.T. AND C.N. WARREN. 1971. Late Pleistocene-early Holocene geomorphic history of Lake Mojave, California. Geol. Soc. Amer. Bull., 82(9):2553–2562.

OSSA, P. AND M.E. MOSELEY. La Cumbre: a preliminary report on research into the early Lithic occupation of the Moche valley, Peru. Inst. Andean Studies, Berkeley, Ñawpa Pacha 9(1971):1–16.

PECK, E.L. AND E.A. RICHARDSON. 1966. Hydrology and climatology of Great Salt Lake: 121–134. *In:* Guidebook to the geology of Utah No. 20, W.L. Stokes, (ed.). Utah Geological Society, Salt Lake City, Utah.

POWERS, W.R. 1973. Paleolithic man in northeast Asia. Arctic Anthrop., 10(2):1–106.

_____. 1975. Dry Creek: a late Pleistocene human occupation in central Alaska. Thirteenth Pac. Sci. Cong., Vancouver, Abstracts of papers, 384.

RALPH, E.K. 1971. Carbon-14 dating. *In:* Dating techniques for the archaeologist, H.N. Michael and E.K. Ralph, (eds.). MIT Press, Cambridge, Mass., 1–48.

RIDGECREST, CITY OF. 1973. Citizens' advisory committee on conservation and open space in cooperation with the Ridgecrest planning commission and staff, Kern County, California, 39–59; 60–63.

ROGERS, M.J. 1939. Early Lithic Industries of the Colorado River? and Adjacent Desert Areas. San Diego Mus. of Man.

ROGERS, M.J., H.M. WORMINGTON, E.L. DAVIS AND C.W. BROTT. 1966. Ancient hunters of the far west. R.F. Pourade (ed.). Copley Books, 1–207.

RUDENKO, S.I. 1961. The Ust' Kanskaia Paleolithic cave site, Siberia. Amer. Antiq., 27(2):203–215.

RUSSELL, I.C. 1889. Quaternary history of Mono Valley, California. Dept. Int. Geol. Surv., Eighth Annual Rept. Director, 3(1):261–394.

SCHLESIER, K.H. 1967. Sedna Creek: report on an archaeological survey on the arctic slope of the Brooks Range. Amer. Antiq., 32(2):210–222.

SEMENOV, S.A. 1964. Prehistoric technology. (M.W. Thompson trans.) Barnes and Noble, 1–211.

SHEPPARD, J.C. 1975. A radiocarbon dating primer. Wash. State Univ., Coll. of Eng. Bull., 338:1–77.

SMITH, G.I. 1968. Late Quaternary geologic and climatic history of Searles Lake, southeastern California. *In:* Means of correlation of Quaternary successions, R.B. Morrison and H.E. Wright, Jr. (eds.). INQUA VII Cong., 8:293–310.

_____. 1977. Paleoclimatic record in the late Quaternary sediments of Searles Lake, California. Paper presented at the Global Scale Symposium on Paleoclimate and Paleolimnology, Kyoto.

SNYDER, C.T. AND W.B. LANGEBEIN. 1962. The Pleistocene lake in Spring Valley, Nevada, and its climatic implications. Jour. Geophysical Res., 67(6):2385–2394.

SNYDER, C.T., G. HARDMAN AND F.F. ZDENEK. 1964. Pleistocene lakes in the Great Basin. U.S. Geol. Survey, Misc. Geol. Invest. Map I–416.

SOIL SURVEY STAFF. 1951. Soil Survey Manual. U.S. Dept. Agr. Handbook 18. U.S. Gov. Printing Office, Washington, D.C., 503 pp.

STALKER, A.M. 1969. Geology and age of the early man site at Taber, Alberta. Amer. Antiq., 34(4):425–428.

STEWARD, J.H. 1933. Ethnography of the Owens Valley Paiute. Univ. California Pub. in Amer. Archaeol. and Ethnol., 33(3):233–350.

_____. 1938. Basin-plateau aboriginal sociopolitical groups. Smithsonian Inst. Bur. Amer. Ethnol. Bull., 120:1–346.

STOCKMARR, JENS. 1971. Tablets with spores used in absolute pollen analysis. Pollen et Spores, 13(4):615–621.

_____. 1973. Determination of spore concentration with an electronic particle counter. *In:* Geol. Survey of Denmark, 1972 yearbook, 87–89.

STORER, J.H. 1953. The web of life. Devin-Adair. New York.

STUIVER, MINZE. 1964. Carbon isotopic distribution and correlated chronology of Searles Lake sediments. Am. Jour. Sci., V. 262, No. 3, 377–392.

TADLOCK, W.L. 1966. Certain crescentic stone objects as a time marker in the western United States. Amer. Antiq., 31(5):662–675.

TAMERS, M.A. 1971. Dates on Taima-Taima, gray sand. IVIC Nat. Radiocarbon Meas. VI, Radiocarbon 13:32–44.

THOMAS, D.H. 1973. An empirical test for Steward's model of Great Basin settlement patterns. Amer. Antiq., 38(2): 155–176.

TIMLIN, J.P. AND B.E. RAEMSCH. 1971. Pleistocene tools from the northeast of North America: the Timlin site. Yager Mus. Pub. Bull., 3:3–21.

TUOHY, D.R. 1969. Breakage, burin facets and the probable technological linkage among Lake Mohave, Silver Lake and other varieties of projectile points in the desert west. Nev. State Mus. Misc. Pap. 6:132–152.

_____. 1974. A comparative study of late PaleoIndian manifestations in the Great Basin. Nev. Archaeol. Surv. Res. Pap. 5:91–116.

VON HUENE, R.E. 1971. Fossil mammals of the Indian Wells Valley region and how to collect them: Maturango Mus. Publ. 5:1–18.

WARDLE, H.N. 1913. Stone implements of surgery from San Miguel Is., California, Amer. Anthrop, N.S. 15(4):656–660.

WARREN, C.N. AND D.L. TRUE. 1961. The San Dieguito complex and its place in California prehistory. Univ. California, Los Angeles, Archaeol. Surv. Annual Rep. 1960–1961:246–338.

WARREN, C.N. 1967. The San Dieguito complex: a review and hypothesis. Amer. Antiq., 32(2):168–185.

WEIDE, D.L. 1969. A petrographic examination of basalt artifacts from the Panamint valley, California. *In:* The western lithic co-tradition, E.L. Davis, C.W. Brott and D.L. Weide, 1969: San Diego Mus. of Man Pap. 6: 79–88.

WEIDE, M.L. 1973. Archaeological inventory of the California desert: a proposed methodology. Archaeol. Res. Unit Univ. California Riverside Dept. Int. DLM Des. Plan. Prog. 04960-PH3-15:1–40.

WELLS, P.V. AND RAINER BERGER. 1967. Late Pleistocene history of coniferous woodland in the Mohave Desert. Science, 155(3770):1640–1647.

WELLS, P. 1970. Vegetational history of the Great Plains: a postglacial record of coniferous woodland in southeastern Wyoming. *In:* Pleistocene and recent environments of the central Great Plains, W. Dort Jr. and J.K. Jones Jr. (eds.). Dept. Geol. Univ. Kansas Spec. Pub. 3:185–202.

WENDORF, F. AND J.J. HESTER. 1975. Preface. *In:* Late Pleistocene environments of the southern High Plains, F. Wendorf and J.J. Hester (eds.). Fort Burgwin Res. Cntr. Pub. 9:vii–ix.

WHEAT, J.B. 1967. A paleo-indian bison kill. Sci. Amer. Jan. 1967, 44–52.

_____. 1974. First excavations at the Lubbock Lake site. *In:* History and prehistory of the Lubbock Lake site. Mus. Jour. XV:15–42. 1974, C.C. Black (ed.). West Texas Mus. Ass'n., Lubbock.

WHEAT, M.M. 1967. Survival arts of the primitive Paiutes. Univ. of Nevada Press.

WRIGHT, H.E. 1970. Vegetational history of the central Great Plains. *In:* Pleistocene and recent environments of the central Great Plains. W. Dort Jr. and J.K. Jones Jr. (eds.). Dept. Geol. Univ. Kansas Spec. Pub. 3:157–172.

WYLIE, H.G. 1975. Tool microwear and functional types from Hogup Cave, Utah. Tebiwa, 17(2):1–31.

ZBUR, R.T. 1963. A geophysical investigation of Indian Wells Valley, California. U.S. Naval Ordnance Test Stn. Tech. Pub. 2795:1–98.

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The Ancient Californians has been written by five individuals with widely different interests, personalities and backgrounds, all of which add to the diversity and flavor of their product.

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Born in Indianapolis, Indiana, in 1915, Ms. Davis graduated from Vassar with a BA in Art, and attended the Pennsylvania Academy of Fine Arts, winning two prizes and a fellowship. She has been a sculptor, product designer, and also has taught art at Reed College and the University of North Carolina.

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Born in Parma, Idaho in 1931, Ms. Panlaqui graduated from the University of Washington in 1953 with a BA in chemistry and worked for the Navy on the China Lake Weapons Center as a general chemist. She had, however, always been intrigued by archaeology and wanted to become an archaeologist; therefore, she worked for 18 months as a weekend, volunteer archaeologist under the direction of Simpson during the active period of the Calico Project. Working in the rocky, hard strata of the Main Pit she became a skilled and observant craftsman.

After the discovery of Paleo artifacts and extinct animals in the basin of Pleistocene Lake China, Ms. Panlaqui became involved with this work, acting as coordinator with Navy Personnel and (together with her husband Clayton) was directly responsible for the successful design of the Mapping Project. Previously, no archaeologist had tackled the problems of mapping bones and artifacts over a broad segment of the Mojave Desert and coordinating these distributions with the sedimentary record.

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